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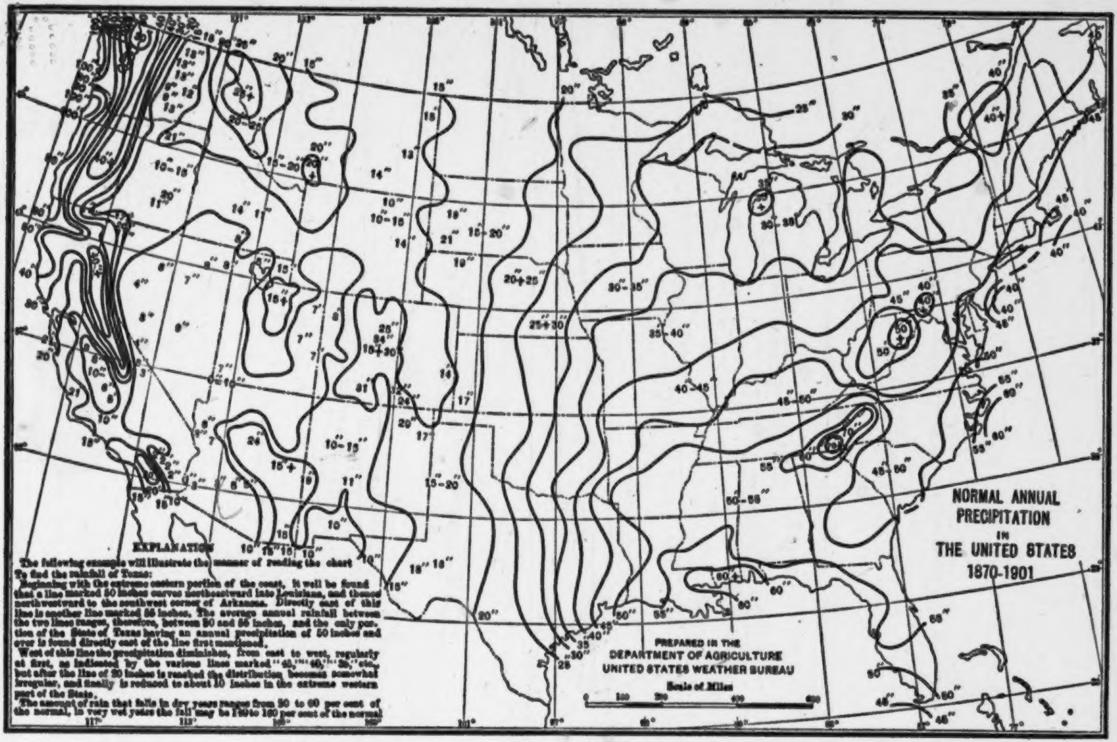
IRRIGATION IN THE UNITED STATES



NORMAL ANNUAL PRECIPITATION
IN
THE UNITED STATES
1870-1901

PREPARED IN THE
DEPARTMENT OF AGRICULTURE
UNITED STATES WEATHER BUREAU

EXPLANATION

The following example will illustrate the manner of reading the chart

To find the rainfall of Texas:

Beginning with the extreme eastern portion of the coast, it will be found that a line marked 50 inches curves northeastward into Louisiana, and thence northwestward to the southwest corner of Arkansas. Directly east of this line is another line marked 55 inches. The average annual rainfall between the two lines ranges, therefore, between 50 and 55 inches, and the only portion of the State of Texas having an annual precipitation of 50 inches and over is found directly east of the line first mentioned.

West of this line the precipitation diminishes, from east to west, regularly at first, as indicated by the various lines marked "45," "40," "35," etc., but after the line of 20 inches is reached the distribution becomes somewhat irregular, and finally is reduced to about 10 inches in the extreme western part of the State.

The amount of rain that falls in dry years ranges from 50 to 60 per cent of the normal, in very wet years the fall may be 150 to 160 per cent of the normal.

IRRIGATION IN THE UNITED STATES

A DISCUSSION OF ITS LEGAL, ECONOMIC AND FINANCIAL ASPECTS

BY

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ENGINEERING, UNITED STATES DEPARTMENT
OF AGRICULTURE

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PREFACE

The construction of works to convey water to land for the irrigation of crops, and the applying of water to crops are quite fully covered by works on irrigation engineering and by bulletins issued by the government bureaus which have dealt with these subjects. There does not seem to be, however, any single publication, either private or governmental, which presents in a popular and non-technical way a general view of irrigation in the United States such as is wanted by the person who wishes to be informed on a subject which has so important a bearing on the welfare of nearly one-half of the area of the country, or by the person who is considering investing in either irrigated land or irrigation securities. The presentation of such a general view of irrigation in the United States is the object of this book. Irrigation engineering and irrigation practice will, therefore, be touched upon only incidentally.

The chapters which follow will deal with climate, water supply, crops, water rights, laws relating to irrigation, systems of controlling irrigation works, organization and control of irrigation enterprises, financing irrigation enterprises, etc.

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PREFACE

The writer has been engaged continuously for sixteen years in the study of these subjects in the United States Department of Agriculture and the Bureau of the Census, having been in charge of the special census of irrigation taken in connection with the thirteenth census. The reports of work done in the Government service have been drawn upon freely. This is especially true of the census reports on irrigation, based on the census of 1910, as these reports give the first numerical measure of the workings of the various Federal and state laws relating to irrigation which has ever been available.

All statements made relating to climate are based on the data contained in *Bulletin Q* of the United States Weather Bureau, and the map (frontispiece) is reproduced from that bulletin.

The writer is familiar with the literature of irrigation in the United States, having edited most of the publications of the Department of Agriculture on that subject issued since 1899, and having used in that editing practically everything published on the subject. Most of the general statements made in this discussion have been published many times, and it is therefore impossible to give credit for them except in this general way. Where specific statements are taken from works already published proper credit is given.

The writer knows of no subject on which there is more popular misinformation than the subject of irrigation. This misinformation relates to some extent to all phases of the subject, but more particularly to the crops grown, the profits which may be expected from them, and investments in irrigation securities. The writer believes in irrigation, and in the West, but he does not believe that the interests of the West can be advanced permanently by overstating the returns which are to be secured from irrigated lands or from the securities behind irrigation investments. He believes that the truth is good enough, and that the interests of the West will be better served by the truth than by exaggeration.

It is hoped that this book may in some small way help the development of the West by presenting, as suggested, a true picture of conditions to be met. Any development forced by misrepresentation must of necessity be unhealthy and be followed by reaction.

While irrigation is usually considered a Western institution, it is spreading with great rapidity in the East. In the East irrigation is a private rather than a public question, since practically all crops can be grown successfully without it, and the application of water in irrigation is merely a means of improvement under some circumstances, like fertilization or intensive cultivation, and its adoption is a question for the individual farmer. It is not the intention to discuss irrigation in the East in this book.

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IRRIGATION IN THE UNITED STATES

IRRIGATION IN THE UNITED STATES

CHAPTER I

THE FIELD FOR IRRIGATION IN THE UNITED STATES

The determining factors in the necessity for irrigation are the amount and the seasonal distribution of the rainfall. For many years a twenty-inch annual precipitation was supposed to mark approximately the line on one side of which irrigation was necessary for the maturing of crops and on the other side of which it was not necessary. During the last few years, however, so-called "dry farming" has made great progress, and the recognized limit of precipitation required for the maturing of crops has been considerably lowered. Or it may be more correct to say that no limit is now recognized. Undoubtedly crops have been successfully matured where the annual precipitation is much less than twenty inches, and crops have failed where it is much over that, but in a general way the lines on the maps marking an annual precipitation of twenty inches form the boundaries between the sections where irrigation is generally practiced, and those where it is not.

A reference to the accompanying map (Fig. 1) shows that in the Great Plains region, from the south line of South Dakota to the Rio Grande, the line of twenty-inch rainfall approximates the one hundred and first meridian of west longitude, and that through the Dakotas the line bears to the east. The eastern boundary of the irrigated region departs from this line at its northern and southern extremities. On the south, irrigation extends down the Rio Grande to its mouth, or to about the ninety-eighth meridian, and on the north it recedes to the west to about the one hundred and third meridian.

In California the line of twenty-inch rainfall strikes the coast a little below San Francisco and runs almost directly north until well up into the Sacramento Valley, where it crosses that valley and runs in a southeasterly direction along the foothills of the Sierras to about the latitude of Fresno, marking almost exactly the present northern extension of irrigation on a considerable scale.

In Oregon and Washington the line follows the eastern foothills of the Cascade Mountains until it reaches southern Oregon, where it bears to the west, marking here, also, the present extension of irrigation. Again, in eastern Washington, northern Idaho, and western Montana the line loops down from the Canadian boundary, cutting out quite accurately the section where irrigation is not practiced.

If great accuracy is not desired, therefore, the line of twenty-inch rainfall may be taken as limiting the sections of the United States where irrigation is generally practiced.

This line indicates the normal annual precipitation, which means that in some years the precipitation is much below twenty inches and in some years much above it, the wet years usually coming in groups, and the dry years in groups. In this way it happens that on the Great Plains in some years crops suffer for lack of water as far east as the eastern boundary of the Dakotas, Nebraska, Kansas, etc., while in other years crops can be successfully grown without irrigation as far west as the base of the Rocky Mountains. This shifting of the rainfall with the seasons has made the settlement of the Plains extremely difficult. With a series of wet years settlement advances, and with a series of dry years it recedes. The hope of continued rainfall deters the construction of irrigation works in many sections, and has caused the financial failure of such enterprises as are undertaken, while the lack of an assured water supply has brought about the failure of the settlers. Probably both the settlers and the builders of irrigation works would succeed if they could give up the hope of changed climatic conditions and work together to maintain and utilize their irrigation works and water supply.

While the line of twenty-inch annual rainfall is the boundary between the region where irrigation is generally practiced and that where it is not generally practiced, throughout the arid region there are small sections where many crops are grown without irrigation, and large sections where grain crops are grown regularly in that way. According to the census returns, every state except Arizona and Nevada has large areas of grain grown without irrigation. On the other hand, within the sections having more than twenty inches of precipitation, there are many places where crops are watered. The most notable instances of this are the rice-growing sections of Louisiana, Texas, and Arkansas. Rice is grown extensively in three quite distinct sections within the states named: along the Gulf coast from Vermilion Bay in Louisiana to Lavaca Bay in Texas, and extending from twenty-five to one hundred miles inland; along the Mississippi River throughout the state of Louisiana; and on the prairie lands in the east central part of Arkansas, between the Arkansas and Mississippi Rivers. Small areas of rice are also grown under irrigation in the Carolinas, Georgia and Mississippi. Physical conditions are favorable to a large extension of rice growing, the essentials being level land with a nearly impervious subsoil, an abundant supply of water which can be placed on the land at a moderate expense, and a warm climate. However, rice growing has not been very profitable for the past few years. The lack of a demand for rice at prices attractive to the grower has been the limiting factor in the extension of rice growing rather than the lack of suitable land or a water supply.

At many points throughout the eastern half of the United States, small areas of trucks and fruit crops are irrigated, and in a few scattered localities other crops are watered. In the South Atlantic states, especially Florida, considerable areas of fruit and winter truck crops are irrigated. Within this section the necessity for irrigation does not arise from a deficiency in annual precipitation, the average annual rainfall in Florida being about fifty inches, but from the uneven distribution of the rainfall. Truck and small fruit crops have short growing periods, and a limited period of drought at a critical stage may ruin such a crop. The frequency of droughts of sufficient duration to injure these crops was brought out in a paper read by Milo B. Williams, of the U. S. Department of Agriculture, at the National Irrigation Congress in Chicago in 1911. On that point he says in part:

> The annual rainfall of eastern Minnesota, Wisconsin, and Michigan ranges from thirty to forty-five inches. Assuming that these states have a growing season from the first day of April to the last day of September, Oshkosh, Wisconsin, received in ten growing seasons twenty-seven droughts having durations of fifteen days or over with less than one inch of rainfall. Sixteen of these droughts came in the spring and early summer, including the one of greatest duration of fifty-nine days. Seventeen droughts were twenty days or over in duration and effective to nearly every crop grown in Wisconsin.
>
> Typical of the North Atlantic states, the normal annual rainfall of New Jersey is approximately forty-five inches, yet during the growing seasons of ten years this section has experienced forty-six droughts with durations from fifteen to fifty-two days. Twenty-eight of these were spring and early summer droughts, the most effective on all crops.
>
> The most humid portion of the agricultural East is subjected to the greatest irregularity of rainfall. I

refer to the southern states bordering on the Gulf of Mexico and the Atlantic Ocean. The normal annual precipitation of this section ranges from forty-five to fifty-five inches, yet we find that Columbia, South Carolina, has experienced in ten consecutive growing seasons sixty-two droughts. Twenty-seven of these lasted between twenty and thirty days; four between thirty and forty days; six between forty and fifty days, and one a duration of sixty-one days.

Throughout most of this section the supply of water for irrigation is abundant, and the question is whether the returns due to irrigation will be sufficient to justify the expense of obtaining and applying the water. Crops are matured without it with sufficient regularity to allow farmers to succeed, and it cannot be said to be necessary. Irrigation will, however, help some crops in almost every year, and in some years almost no crops can be grown without it. Its desirability is purely a local affair to be settled in each particular case. It is probable that the future will witness a still greater extension of the irrigated acreage in the East.

CHAPTER II

HISTORICAL

Within the territory now comprising the arid region of the United States, irrigation has been practiced to a limited extent from prehistoric times. When the Spanish explorers entered the territory now forming the states of New Mexico and Arizona, they found the remains of ancient aqueducts and found the natives watering their crops. The Spaniards who remained in this territory continued and extended this practice, as the country was uninhabitable without it. In extent the practice was very limited, however, being confined principally to the Pueblos of the Indians and the missions of the Catholic fathers. This condition prevailed until about the middle of the nineteenth century, when American settlers began to come into the West from the East and North.

The beginning of irrigation in the United

States by Americans is usually attributed to Brigham Young and the Mormon pioneers who settled in the Salt Lake Valley in 1847, and there has been considerable discussion as to whether Young had seen irrigation previously or whether it was "revealed" to him. This question is not important, but there is no doubt that there was plenty of opportunity for either him or some of his followers to have seen irrigation in this country, and elsewhere. The fact is that in many parts of the West permanent habitation without irrigation was impossible, and wherever permanent settlements were made, either in the Southwest, in Southern California, or in Utah, the settlers soon began applying water to the soil for the production of crops. The Mormon settlement in Utah and the discovery of gold in California occurred at about the same time, and both the Mormon farmers and the California miners were compelled to irrigate to live.

During his life Brigham Young insisted that the Mormon people should make agriculture their chief industry, but outside of Utah irrigation remained for some years an incident to mining or stock raising, although it was practiced in this way throughout the West. From these small beginnings irrigation gradually spread, until 1870, when the first considerable colony depending on irrigated agriculture was founded at Greeley, Colorado, under the patronage of Horace Greeley.

The first great boom in irrigation construction occurred in the late eighties and early nineties, when many large enterprises were undertaken by promoters who hoped to profit by the great increase in land values created by irrigation. Few of these undertakings were successful financially, although they resulted in a large extension of the irrigated acreage. This boom in irrigation construction was followed by a long period of depression during which little construction took place, lasting until 1902 or 1903.

During this period of inactivity Congress passed the Carey Act, to remedy what seemed to some to be the principal difficulty, the inability of the builders of irrigation works to secure control of the public lands to be served by these works and compel these lands to contribute to the cost of the works. This law granted to each of the states containing arid lands a million acres of such land, on condition that the state provide for its reclamation. The law was little utilized for a number of years and has not, up to the present time, brought under irrigation any considerable portion of the total acreage irrigated, although it is being utilized to a much larger extent than during the years immediately after its passage (see page 67).

In 1902 Congress enacted the Reclamation Law, providing for the construction of irrigation works by the Federal Government with the proceeds from the sale of public lands, and at about the same time construction by private agencies revived. This period of Federal and private activity continued until about 1910, when the United States Reclamation Service had expended its accumulated funds, and the failure of several large private enterprises checked the construction of irrigation works by such agencies.

The first enumeration of irrigated lands in the United States was made in connection with the census of 1890, and showed a total acreage irrigated in 1889 of 3,631,381 acres. The census of 1900 showed that in 1899 the acreage irrigated had increased to 7,527,690 acres, or had a little more than doubled in ten years. In 1909 the acreage had increased to 13,738,485 acres, not quite double the acreage irrigated in 1899. From these figures it appears that during the sixty-two years from 1847, when modern irrigation began, to 1909, the date of the last census, the acreage irrigated increased at the rate of about 222,000 acres per year; during the period from 1889 to 1899 it increased at the rate of about 390,000 acres per year; and during the last decade at the rate of about 621,000 acres per year.

Statistics of the acreage irrigated since 1909 are not available, but since that time irrigation development was rapid for a year or two, and later has been almost at a standstill. It is probable that the acreage irrigated in 1914 was about 15,000,000 acres.

CHAPTER III

CLIMATIC CONDITIONS IN THE ARID REGION

The distinguishing characteristics of the climate of the western part of the United States are the small amount of rainfall, the low humidity, and the large amount of sunshine. As previously stated, the line of twenty-inch rainfall marks approximately the eastern boundary of the irrigated section. The western portion of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas fall within a zone receiving from fifteen to twenty inches of precipitation. The larger parts of Montana, Wyoming, Colorado and New Mexico receive from ten to fifteen inches annual precipitation, with more in the high mountains. The southern part of Idaho, the eastern part of Arizona, the north central part of Utah, and the eastern parts of Washington and Oregon also fall within this zone. The great central basin between the Rocky

Mountains and the Sierra Nevadas, extending from the southern line of Idaho to the Mexican line, except the drainage basin of the Great Salt Lake, receives less than ten inches of precipitation annually. This section includes the valleys of the Green and Grand Rivers in western Colorado and eastern Utah, the valley of the Colorado River in Utah, Arizona, and California, almost the entire state of Nevada and the southwestern part of California. The lowest precipitation in the United States occurs in southeastern California and southwestern Arizona, where it ranges from one to three inches per year. The precipitation in the coast counties of southern California is about fifteen inches, in the San Joaquin Valley it ranges from five to ten inches, and in the Sacramento Valley from fifteen to twenty inches.

In the Plains region the precipitation is very favorably distributed for crop production, the larger part occurring during the growing season. The same thing is true of the Rocky Mountain districts. In the Great Basin lying between the Rocky Mountains and the Sierra

Nevadas, a larger proportion of the precipitation occurs in the winter and spring months, the summers being dry and hot, with some rainfall, however. In Arizona and New Mexico the larger part of the rainfall comes in torrential storms in the summer months; while on the Pacific slope, especially in California, there is an almost entire absence of rainfall in the summer, and heavy precipitation in the winter.

The relative humidity throughout the arid region is low. Along both coasts of the United States it ranges from seventy-five to eighty per cent., in the Great Basin it ranges from fifty to sixty-five per cent., while in the Southwest—Arizona and New Mexico—it sinks in the late summer to twenty and thirty per cent. This low humidity characteristic of the arid region renders the extremes of heat and cold much more endurable than are the same temperatures in regions of greater humidity and the climate generally more pleasant.

For the United States as a whole the percentage of sunshine is about fifty per cent.

That is, the sun shines during about one-half of the time between sunrise and sunset. The region of maximum sunshine is in the extreme Southwest, where, on the average for the year, the sun shines at least seventy per cent. of the time. For the Rocky Mountain and Great Basin districts the average is about sixty-five per cent., with a maximum of seventy-six per cent. at Santa Fe, New Mexico, and a minimum of fifty-six per cent. at Helena, Montana. For the Pacific Coast states the average is about sixty per cent., with a maximum of seventy-three per cent. at Los Angeles, California, and a minimum of forty-one per cent. at Portland, Oregon. Omitting Portland from the average, it is sixty-four, or about the same as the average for the Rocky Mountain and Great Basin regions.

The combination of small rainfall and large amount of sunshine, while it creates the necessity for irrigation in the arid region, is in every other way very much to the advantage of agriculture. Where the necessary moisture is supplied by irrigation, conditions are ideal both for growing and harvesting crops. The farmer can plant, cultivate, and harvest his crops at the proper seasons and times, instead of waiting, and hoping that the weather will be not too wet or too dry for planting, that there will be enough rain to keep his crops growing and yet not so much that he cannot cultivate, that it will not be so wet that he cannot harvest his crop when it is mature, and that it will not rain on his grain or hay crop when it is down. From all of these things the farmer under irrigation is largely relieved.

The arid region extends through such wide ranges of latitude and altitude that there is a very wide range of temperature. However, one characteristic is common to the whole region. The days are warm, and the nights are cool. This characteristic of the climate, together with the sunshine and freedom from rain, makes the arid region an especially enjoyable place of residence. The most notable effect of the cool nights on the agriculture of the region is the inability to grow corn to advantage, as this crop does best where continuous hot weather prevails. Corn is the only cultivated crop which, according to the census returns, does not show larger average yields under irrigation than without it.

CHAPTER IV

WATER SUPPLY

STREAMS

The water supply used for irrigation in the arid region comes principally from streams, more than ninety-four per cent. of the land irrigated in 1909 being supplied from that source. With few exceptions the streams used for irrigation have their sources in the mountains, and depend for their flow largely upon the melting snows. Because of this fact the prevailing characteristics of their discharge are a flood season in late spring and early summer with the melting of the snow from the greater part of the mountain areas, and a low summer flow coming from the melting of the remaining snow banks and glaciers, from seepage from saturated lands, and from underground sources. Illustrating this, a tabulation of the flow of twelve of the largest streams draining the Rocky Mountains and the east side of the Cascades shows the aggregate June discharge of these streams in 1909 to have been nearly four times as great as the aggregate August discharge of the same streams in that year. This ratio is probably representative of the normal discharge of the streams of the arid region as a whole.

As a result of this characteristic there is, in most stream valleys, more water than can be used economically in the flood season and a serious shortage in the late summer. This is the prevailing condition in the arid region, although the late summer flow of some of the larger streams—the Missouri, the Colorado, and the Columbia Rivers—has not been fully utilized as yet. The Missouri River cannot be diverted to advantage under present conditions; on the upper reaches of the Colorado there is not sufficient arable land to utilize the water, but on the lower reaches there are now under way projects which will utilize most of the summer flow; and throughout most of its course the Columbia flows in such a deep channel that its waters must be pumped to the lands to be served. Several projects to utilize the waters of this river are under way. Taking the arid region as a whole, therefore, it is generally true that the extension of irrigation from streams requires the storage of the flood and winter flow of these streams for use in the late summer when the streams are low. On many streams this condition has prevailed for several years and much of the flood water is stored, the census returns for 1910 showing 6,812 reservoirs, with storage capacity of 12,581,129 acre-feet. Some of these reservoirs, like those of the U. S. Reclamation Service on the Shoshone and North Platte Rivers in Wyoming, and the Salt River in Arizona, are large enough to store the entire flow of the streams on which they are situated, while others are very small and store only the discharge of a small pump for a few days or a few hours. On each of the streams named the entire flow is to be stored in a single large reservoir in the channel of the stream. On the South Platte and its tributaries and the Arkansas, in Colorado, on the other hand, the flood waters are stored in many small reservoirs outside the stream channels. On still other streams, such as the Snake River in Wyoming and Idaho, the Yakima River in Washington, and the Truckee River in California and Nevada, the flood waters are stored, in part at least, in lakes on the headwaters of the streams.

No complete statement of the supply of water available for irrigation from the surface flow of streams in the arid region can be made, as the measurements made by the U. S. Geological Survey do not include all the streams, and streams which have been measured are so largely affected by diversions and seepage losses, and by inflow from tributaries and seepage, that the measured discharge at any point seldom represents the supply available below that point. In a report on the "Surface Water Supply of California, 1907-8," by W. B. Clapp and W. F. Martin,[1] after stating in detail how the water of the Santa Ana River is utilized, the authors state, "It is thus evident that the same water, in passing from mountain to sea, a distance of not more than 100 miles, may be used at least eight times for power and irrigation. In like manner the water in many of the tributaries may be used several times before reaching the main stream."

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[1] *Water Supply Paper, 251,* U. S. Geological Survey, p. 124.

Similar observations on the South Platte River in Colorado, reported by the Department of Agriculture,[1] show that the diversions from that stream in July, 1903, were slightly more than four times the visible inflow, and in August the diversions were only slightly less than three times the visible inflow. This increase is attributed entirely to return seepage from irrigated land, and the measurements reported in the bulletin referred to show that the return seepage was increasing from year to year.

Undoubtedly the same conditions exist on most of the streams of the arid region. The soil of the stream valleys is filled with water by irrigation, and this water seeps through the soil toward the natural drainage channels and finally appears in the streams as an addition to the surface flow, which can be diverted and used again, to again contribute to return seepage further downstream. Thus, on a long stream, such as the South Platte, the same water may be used several times before passing into the air or out of the region where it is needed for irrigation.

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[1] "Water Rights on Interstate Streams," by R. P. Teele and Elwood Mead, U. S. Dept. Agr., O.E.S., *Bulletin 157*, p. 55.

STORAGE OF STORM WATERS

In the arid region very large areas of arable land, especially on the Great Plains, lie beyond the reach of canals from streams. This land must depend for a water supply either upon underground water or the storage of storm water. The land is rolling, and there are many opportunities for making reservoirs in the depressions for the holding back of water draining into these depressions during storms. These reservoirs are made by throwing earth dams across drainage channels at points where the topography is such that they will provide considerable storage capacity. The water is withdrawn through outlet pipes near the bottoms of the dams, and conducted to lands lying at lower levels. Individual reservoirs are small, but in the aggregate they supplied water to nearly 100,000 acres in 1909. This source is capable of very much larger development than has yet taken place. Much of the water which might be utilized in this way would eventually reach the streams if not used and consequently this cannot be considered entirely as an addition to the supply from streams. On the Plains, however, where most of the reservoirs of this type are located, much of the water stored in this way would reach the streams too far down to be used for irrigation, and it is in fact an addition to the previously available supply.

GROUND WATERS

Ground waters used for irrigation come from three sources: springs, flowing wells, and pumped wells.

Springs.—Springs supplied water to nearly 200,000 acres of irrigated land in 1909. They are quite generally distributed over the arid region, the smallest areas irrigated from this source being reported from the Plains states. It is not likely that there is opportunity for much larger use of this source of supply, and, naturally, it is not one which can be increased to any considerable extent by human agencies.

Flowing Wells.—Flowing wells have been extensively used in but two of the arid states—California and New Mexico—up to the present time. The total acreage irrigated from this source in 1909 was about 144,000 acres, more than 120,000 acres of which was in the two states named. The two fields most extensively developed at present are in Southern California and in the Pecos Valley, New Mexico. In both of these sections the heavy draft on the underground supply by the opening of new wells has lowered the water level, and many wells which once flowed have ceased to flow and must be pumped if used, indicating that the quantity of water which can be taken from an underground source is as definitely limited as that which can be taken from a stream.

In southern California the well owners have come to realize this fact, and have taken steps to replenish the supply from year to year. In that section the flowing wells are located in the lower levels of débris cones at the mouths of canyons of streams issuing from the mountains. These streams have heavy floods in the rainy season and in the spring when the snow melts, and there is little opportunity to store the flood water in reservoirs. These floods flow over the débris cones and a part of the water sinks into the ground and helps to fill the underground reservoirs. The plan adopted is to spread the flood waters as widely as possible over the higher parts of the cones in order that a large part of it may find its way into the earth. Under the peculiar conditions existing in that section, where the source of the water is apparent and the point of use is nearby, it is possible to increase to a considerable extent the supply of water which can be obtained from flowing wells. In other artesian basins the source of the water is not known or is not subject to control, except as to the amount of water withdrawn, and there it is not possible for man to increase the supply.

The known artesian basins are rather limited in extent. Other basins will undoubtedly be developed from time to time, but it does not appear from the present development and the investigations of the U. S. Geological Survey that flowing wells will provide water for a very large extension of the acreage irrigated.

Pumped Wells.—Pumped wells ranked next to streams in extent of acreage supplied with water for irrigation in 1909, but they supplied only a little more than 300,000 acres, or about two per cent. of the total acreage irrigated in that year. Nearly three-fourths of the wells pumped for irrigation and about nine-tenths of the acreage irrigated from this source are in southern California.

The supply of ground water which can be made available for irrigation by pumping is much greater than that which can be obtained from flowing wells, since ground water occurs very generally, while flowing wells occur only under peculiar geological conditions. Up to the present, at least, the limited use of water from pumped wells has not been due to the limited volume of water available but to the cost of pumping. It is probable that, as the cost of securing water by gravity diversions from streams rises, there will be an increasing use of water pumped from wells.

The use of water for irrigation constantly adds to the available supply of ground water, and in many irrigated sections the water has come so near the surface as to injure crops. In such places this water can be pumped to the surface at small expense for use in irrigating other land, at the same time benefiting the land from which it is pumped.

It is probable, therefore, that in the future there will be a very large increase in the acreage irrigated with water pumped from wells, although the supply of water is not unlimited, and increasing draft on this supply will lower its level and increase the cost of pumping in such a way as to discourage the exhaustion of the supply.

CHAPTER V

CROPS

The fundamental and final test of all agricultural effort is the relation between cost and returns, and this in turn is based on the crops grown. Irrigation, applied to agriculture, is merely one factor in crop production. Moisture is necessary to the growth of plants, and if it is not supplied in sufficient quantity by nature, the deficiency can be supplied by man. In sections of what is termed the arid region this deficiency is so great that the production of any agricultural crops is impossible without irrigation; in other sections some crops can be produced without it, but their growth is uncertain and stunted, and the range of crops is very limited; while in other sections many crops can be grown with reasonable success without irrigation, and the supplying of water artificially becomes merely an insurance against drought or a means of producing larger or better crops than could be grown otherwise. The practice of irrigation, therefore, according to the climate, ranges all the way from an absolute necessity, without which agriculture cannot exist, to a mere means of improvement, like thorough cultivation, fertilization, or crop rotation. In every case, however, the real question is whether the crop returns which are obtained as a result of irrigation are sufficient to justify the expense of providing a water supply in addition to the other expenses of crop production. It will be seen that this is a complicated question, and the answer depends upon a large number of factors—the kind of crops grown, the yields and prices obtained, the cost of land, equipment, seed, and labor, as well as the cost of water. Too often the literature on this subject, especially the advertising literature, deals with the question as if it were a question of yields and cost of water only. The average farmer of the United States who, in 1909, raised 106 bushels of potatoes per acre, worth $45.36, and 15.4 bushels of wheat per acre, worth $14.86, cannot see how the farmer who raised 300 bushels of potatoes per acre or 60 bushels of wheat per acre can fail to be prosperous. But the statements of large yields, while they may be strictly true, give no basis whatever for determining the advantages of irrigation. The grower who got 300 bushels of potatoes per acre may have had only a single acre of potatoes on a farm of 160 acres, and that crop may have been raised at a large expense for labor and fertilizers, and he may have had no market for even the small quantity which he raised.

It is very unfortunate that there is not available somewhere comprehensive data as to the cost of producing crops, either with or without irrigation. The last census does afford, however, quite comprehensive figures as to crops grown both with and without irrigation, and as to the cost of irrigation, and it is on averages covering wide areas, such as those given by the census, that decisions should be based, and not on isolated instances which may or may not be representative.

The census reports referred to show that by far the larger part of the irrigated land of the arid region of the United States is devoted to what are commonly called "general farm crops" rather than to the high-priced vegetable and fruit crops which appear so prominently in the advertising literature of land agents. Nearly two-thirds of the total acreage of irrigated crops reported for the year 1909 was devoted to hay, principally alfalfa and wild grass, the crops from which had an average value of $16.31 per acre. About one-fifth of the total acreage was in grains, which gave an average return of $20.29. Only about one-twentieth of the acreage was in fruit crops, and the average return from these was almost exactly $100 per acre. Potatoes, which show average returns of $60 per acre, occupied but 2.3 per cent. of the acreage, and sugar beets, with an average return of $57.29 per acre, occupied 2.5 per cent. of the acreage. Miscellaneous small fruit and vegetable crops, which showed an average value of $58.43 per acre, occupied 4.6 per cent. of the acreage. The average value for all crops raised by irrigation in 1909 is reported as $25.08 per acre, and all of the crops reporting higher average values—tropical and subtropical fruits, orchard fruits and grapes, miscellaneous small fruits and vegetables, potatoes and sugar beets—together occupied but 14 per cent. of the acreage of irrigated crops reported.

It is evident, therefore, that the large yields and the high crop values so much exploited are not the rule but the exception. The truth is that the larger part of the irrigated land, like the larger part of all farm land, is devoted to the general crops which bring quite moderate returns; and that only a small part of the irrigated land, as of other land, is devoted to the high-priced crops. In other words, irrigation farming is not bonanza farming, but just plain farming, with the added feature of applying water artificially, which involves added cost and added labor, which are offset, however, by added crop returns.

With the exception of corn and wild grass, every crop reported by the census as irrigated showed larger average yields per acre under irrigation than were reported for the same crops for the United States as a whole, the percentages of excess of yields on irrigated lands over yields on unirrigated lands ranging from 18.7 per cent. for grains cut green for hay, to 67.3 per cent. for wheat, the average excess yield for crops for which comparisons can be made being 28.6 per cent. That is to say, on the average, the yields of crops are a little more than one-fourth larger on irrigated land in the West than on unirrigated lands in the country as a whole.

Coming to individual crops, the yields per acre on irrigated and on unirrigated lands for the leading crops are as follows: alfalfa, irrigated 2.94 tons, unirrigated 2.14 tons; oats, irrigated 36.8 bushels, unirrigated 28.5 bushels; wheat, irrigated 25.6 bushels, unirrigated 15.3 bushels; potatoes, irrigated 153.6 bushels, unirrigated 103.8 bushels; sugar beets, irrigated 11.89 tons, unirrigated 9.70 tons. Comparisons for fruit crops cannot be made for the reason that the census does not report fruit yields on an acreage basis, but it is probable that the same rate of increase holds for these crops as for the others.

It is evident to anyone familiar with farming that the averages given do not represent the yields obtained by good farmers on good lands, either irrigated or unirrigated, but averages based on such large acreages do undoubtedly fairly represent the relative possibilities of crop production for the two sections. The good farmer in the irrigated region can grow about one-fourth larger crops than the good farmer in the humid region.

Prices in the West range higher than they do in the East, and consequently the difference in money returns per acre for crops is greater than the difference in yields. Every crop for which comparisons can be made on the census figures shows a larger average value of crop per acre for irrigated land than for unirrigated land, and on the basis of the total acreage and the total value of these crops on irrigated and unirrigated land, the average crop value for irrigated land averages 43 per cent. higher than the average value for crops on unirrigated land. As with the average yield, this comparison does not include the fruit crops. It seems fair to assume, however, that the same rate of increase would apply to these crops. As stated, the average crop value for irrigated lands is given as $25.08 per acre, and, on the assumption just made, the average value for unirrigated land for the United States as a whole is $17.54 per acre, and the excess for irrigated land is $7.54 per acre.

Against this excess average value per acre for irrigated crops must be charged the cost of obtaining a water supply and of applying the water to crops, as well as the cost of leveling land and of building farm ditches. The annual cost of irrigating should include interest on the cost of the works necessary to supply water, of farm ditches and of leveling land; the annual cost of maintenance and operation of works; and the cost of applying water.

The average first cost of irrigation enterprises, as given by the census of 1910, was $15.92 per acre, and the cost of farm ditches and of leveling land and getting it ready for the application of water is estimated at about the same figure. The interest on the initial investment thus computed, at 8 per cent., would be $2.55 per acre; the annual cost of operation and maintenance of irrigation enterprises, as shown by the census reports, was $1.07 per acre; the average annual cost of applying water to land is reported by the U. S. Department of Agriculture as ranging from $2.28 to $4.90 per acre, with an average of $3.64.[1] The sum of the three items just given, $7.26, may be taken as a fair statement of the annual cost of irrigation per acre. Assuming that, outside of irrigating, the cost of producing crops is the same with and without irrigation, there is a slight advantage in favor of irrigation.

The assumption just made may or may not be true. No figures showing the general cost of producing crops under the two systems of farming are available. The arid region has many advantages for the farmer. Perhaps the chief of these is the clear, rainless weather which prevents the loss of time on account of bad weather, and the loss of crops from the same cause. So far as the weather is concerned, all agricultural operations can usually be performed at the time when they should be—planting, cultivating, and harvesting can be done at the proper time, without danger of interruption. These conditions tend to reduce the cost of producing crops in the arid region, since men, teams, and machinery need never be idle because of the weather, and crops will not be destroyed after large expenditures of time and money have been made in the purchase of seed, fertilizers, etc., and in planting, cultivating, and harvesting. Where the water supply is ample, there is also an assurance that crops can be brought to maturity, which does not exist where farmers depend upon rainfall. This condition also tends to lower the cost of producing crops in the irrigated region.

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[1] U. S. Department of Agriculture, Office of Experiment Stations, *Bulletin 145*, p. 84.

The advantages just enumerated are, however, partially offset by higher wages and general higher prices for supplies of all kinds in the West than in the East. It seems probable, however, that the advantages of farming under irrigation over farming without it are greater, rather than less, than is indicated by the figures given.

In the following paragraphs the individual crops grown under irrigation are discussed with reference to their geographical distribution, yields, values, etc. They are taken up in the order of the extent of the irrigated acreage devoted to each, as shown by the last census.

ALFALFA

Alfalfa is more extensively grown on irrigated land than any other crop, occupying nearly one-third of the irrigated acreage. It is grown practically everywhere that irrigation is practiced, being valuable not only for the crops harvested, but for loosening up and adding humus to new lands, and for maintaining the fertility of older lands by rotation with other crops.

Alfalfa is peculiarly adapted to irrigation because of the short period of time required for maturing a crop. If water is available for irrigation, two, and usually three crops can be grown each season, even to the northern limits of the United States, while in the extreme South six, eight, and sometimes ten crops are grown per year. As a rule, in sections where irrigation is not practiced, the late summers are dry, and only one or two crops at best can be grown each season on account of lack of moisture. For the United States as a whole, approximately one-half the land in alfalfa is irrigated.

In total value as well as acreage alfalfa is the leading irrigated crop, representing twenty-eight per cent. of the total value of irrigated crops reported by the census for 1909. In each of the arid states, except California and Montana, the value of the irrigated alfalfa crop exceeded the value of any other irrigated crop, tropical and subtropical fruits exceeding it in California and oats in Montana.

In average value per acre of the crops harvested, however, alfalfa falls below the average for all irrigated crops, its average as shown by the census being $22.94 per acre, while the average reported for all crops was $25.08. The value reported for alfalfa, however, relates only to the crops harvested. Most alfalfa fields are used for pasture during some part of almost every year, so that the crops harvested do not represent the entire annual returns from the fields, while the usefulness of the crop as a fertilizer adds still further to its value. In fact, it is the value of alfalfa as a fertilizer which causes it to be so generally grown.

WILD GRASSES

Wild grass followed alfalfa in the extent of the acreage of irrigated land occupied, covering a little more than one-fifth of the total acreage of irrigated crops in 1909. While this crop occupied a large acreage, it represents the lowest type of irrigation development. The land in this crop receives no preparation for irrigation, and the crop is usually grown in connection with stock raising in sections where large areas of cheap land are available. Considerable areas are also irrigated in new enterprises where settlers have not had time to put the land in crops which, while bringing larger returns, require more preparation.

The average value per acre for this crop shown by the census was $7.67, which was lower than that for any other irrigated crop. However, the cost of producing this crop is probably lower than that of producing any other irrigated crop, as the land on which it is grown receives no preparation for irrigation or other cultivation and is usually irrigated but once during a season—in the spring, when the streams are in flood and water is abundant—and the works conveying water to the land are usually simple and inexpensive. In net returns, therefore, this crop ranks higher than in gross returns.

More than half of the acreage of irrigated wild grass is in the Plains states, Montana and Wyoming having the largest areas.

OATS

Oats holds the third place in respect to acreage among the crops grown on irrigated land, showing about one-tenth of the total acreage reported for irrigated crops in 1909. This crop is grown extensively on new land just being brought under irrigation and also in isolated localities in connection with stock raising. It is adapted to high altitudes and short growing seasons, and is grown in mountain valleys.

As in the case of wild grass, the largest areas of irrigated oats are found in the Plains states, Colorado having the largest area and Montana the next largest.

The average value of irrigated oats per acre was, in 1909, $19.00, while the average value per acre for the whole United States, including irrigated land, was but $11.79, and, excluding the irrigated land, but $11.64. The cost of producing oats is low in comparison with that of cultivated crops, since there is little expense for cultivation; but it is higher than the cost of producing perennial hay crops which do not require plowing and seeding each year.

The average yield of oats on irrigated land in 1909 was 36.8 bushels per acre, as against 28.5 bushels per acre for unirrigated land.

WHEAT

Wheat ranks fourth in area among the crops grown under irrigation, having had about eight per cent. of the acreage in all irrigated crops in the United States in 1909. It is grown both with and without irrigation in all of the arid and semi-arid states. As this crop is grown throughout the United States, the wheat grown on irrigated land is an unimportant part of the crop for the whole country.

Wheat is grown on new lands and is grown also in rotation with other crops on older lands. It is not a high-valued crop, however, and consequently is not grown extensively where land and water are high-priced. The average value per acre for irrigated wheat in 1909 was $23.40, as compared with an average value for unirrigated wheat for the United States of $14.75. The average yield per acre exceeded the average for unirrigated wheat in a higher proportion, the average for irrigated land being 25.6 bushels per acre, and the average for unirrigated land 15.3 bushels per acre.

BARLEY

Barley ranks next to wheat in the extent of the acreage irrigated, but reported in 1909 only about half as much acreage as wheat. It ranks even lower in value than in acreage, the average value per acre for irrigated land being but $18.32, while the average for the unirrigated land in the United States in 1909 was $11.81.

Barley is more extensively grown under irrigation in California and Colorado than elsewhere, being grown very extensively in the Imperial Valley, California. It is grown on new lands and gives place to more valuable crops as the country develops.

FRUITS

All irrigated fruit crops combined had an acreage of about 350,000 acres in 1909, which constituted a little less than five per cent. of the entire acreage of irrigated crops. About 165,000 acres of this was in orchard fruits, including apples, peaches, pears, apricots, and prunes; about 100,000 acres was in tropical and subtropical fruits, principally oranges; about 70,000 acres was in grapes; and about 15,000 acres was in small fruits. California leads in the acreage of irrigated fruits of all kinds, having about sixty-three per cent. of the orchard fruits and grapes, ninety-nine per cent. of the tropical and subtropical fruits, and nearly one-half of the small fruits. Colorado ranks second to California in both orchard fruits and grapes and small fruits, having about fifteen per cent. of the orchard fruits and about seven and a half per cent. of the small fruits. Washington ranks third in both orchard fruits and grapes and small fruits.

Outside of the states named, irrigated orchard fruits are quite generally distributed, all of the arid and semi-arid states except North Dakota reporting some acreage. The average returns per acre for such fruits was $76.36 per acre, although the average in three states was above $100 per acre—Colorado, Oregon, and Washington. Colorado shows the highest average returns, $121 per acre.

Only three states report irrigated tropical and subtropical fruits—Arizona, California, and Texas—and almost the entire acreage is in California. The average return per acre was $154, which is just about double the return for orchard fruits.

Small fruits are pretty well distributed. They show higher returns per acre than either orchard or citrous fruits, the average shown by the census being $185 per acre. California has both the largest acreage and the highest returns, the average return being $232 per acre.

SUGAR BEETS

Sugar beets are an important irrigated crop, although they occupy a comparatively small part of the irrigated acreage—two and one-half per cent. in 1909. The irrigated acreage forms a larger part of the total acreage in this crop than is the case with any other crop, more than half the acreage in sugar beets in the whole country being irrigated.

While all the arid and semi-arid states grow some sugar beets, the acreage in the Dakotas, Nevada, New Mexico, Oklahoma, Texas, and

Washington are unimportant. Colorado grows considerably more than half the irrigated beets of the country and more than four times as much as the state showing the next largest acreage. Utah, Idaho, California, and Montana also grow considerable acreages. The bulk of the sugar-beet area in Colorado is in the valley of the South Platte and its tributaries, a single county, Weld, having a larger acreage of irrigated beets than any state other than Colorado. In that section of Colorado beets are grown in rotation with potatoes, alfalfa, and grain, the most common rotation period being six or seven years. Beets and potatoes each occupy the land two or three years, alfalfa one or two years, and grain the remainder of the period.

The average value per acre for irrigated beets is more than double the average value for all irrigated crops, the value for 1909 being $57.29, while the average value for all crops was $25.08. Irrigated beets, however, showed very little excess value per acre over unirrigated beets, the value reported for the latter being $51.87 per acre.

The cost of growing beets is much higher than that of growing the grain and hay crops, and consequently the net profits are not so much higher than those for other crops as might be expected from the high gross returns. Beets require a large amount of hand labor, which runs up the cost. However, the value of the crop is high enough to make this crop more profitable than the others.

It is feared by many that the reduction of the tariff on sugar, provided for in the law of 1913, will destroy the beet-sugar industry of the arid states, but the law has not yet been in force long enough for its effect on the industry to be determined. Beet growing is not popular with the farmers, and in some localities the promoters of factories have difficulty in getting the farmers to plant the acreage necessary to insure sufficient beets to make the building of factories practicable. If the price of beets to the farmers is reduced to any appreciable degree it is probable that many of them will stop growing beets until better prices are paid.

POTATOES

While they do not cover a large part of the irrigated acreage, potatoes are an important crop in certain sections of the West. This crop is so generally grown throughout the United States that the irrigated crop is not an important part of the whole crop.

As is the case with sugar beets, Colorado grows a large part of the irrigated potatoes —more than one-third of the total. And Weld County, which has a larger acreage of sugar beets than any state other than Colorado, takes the same rank with respect to potatoes, except in California. Potatoes rank next to the fruit crops in average value per acre, the average value in 1909 being $60.03.

Although potatoes are a common "dry farm" crop, they show greater increases on irrigated land as compared with unirrigated land than most other crops, the average yield per acre on irrigated land in 1909 being 153.6 bushels, against an average of 103.8 for unirrigated beets in the United States as a whole.

The cost of growing potatoes is about the same as that of growing sugar beets, so that the net returns per acre are a little larger. The cost is, of course, much larger than that of growing grain and hay crops.

CHAPTER VI

LEGISLATION RELATING TO IRRIGATION

The Federal and state laws dealing with irrigation are briefly summarized below, with statements showing what has been accomplished under them.

FEDERAL LEGISLATION

The Federal Constitution makes no direct reference to irrigation or to the diversion of water from steams. Article IV, Section 3, providing that "Congress shall have the power to dispose of, and make all needful rules and regulations respecting the territory or other property belonging to the United States," has a bearing on irrigation for the reason that most of the land in the arid region was at one time the property of the United States. Amendment V, providing that "No person shall be deprived of life, liberty or property without due process of law; nor shall private property be taken for public use without just compensation,'' also has a bearing on irrigation, as the laws of most of the arid states provide that the use of water for irrigation is a public use, permitting of the condemning of private property for rights of way.

The first Federal legislation relating directly to irrigation was the Act of July 26, 1866. It is quoted in full below because it has been held that by this Act, and an amendment approved July 9, 1870, the Federal Government surrendered any control it might have had over the non-navigable streams of the arid region by reason of being the owner of the lands of that section:

> Whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing or other purposes, have vested and accrued, and the same are recognized and acknowledged by local customs, laws and the decisions of courts, the possessors and owners of such vested rights shall be maintained and protected in the same, and the right of way for the construction of ditches and canals for the purpose herein specified is acknowledged and confirmed;

> whenever any person, in the construction of any ditch or canal, injures or damages the possession of any settler on the public domain, the party committing such injuries or damage shall be liable to the party injured for such injury or damage.[1]

The amendment of July 9, 1870, is as follows:

> All patents granted, or preëmption or homesteads allowed, shall be subject to any vested and accrued water rights, or rights to ditches and reservoirs used in connection with such water rights, as may have been acquired under or recognized by the preceding section.[2]

It will be noted that under these laws the development of irrigation is left to "local customs, laws, and the decisions of courts," and in that sense all irrigation is done under state laws.

The Desert Land Act.—The Desert Land Act, approved March 3, 1877, provided for the procuring of title to 640 acres of arid land by conducting water upon and reclaiming the same within three years from the filing of a declaratory statement, and the payment of $1.25 per acre. Patent is not granted until proof is made that the applicant has expended at least $3 per acre in improvements, and that at least one-eighth of the land has been actually reclaimed. This Act applied originally to the states of California, Oregon, and Nevada, and to Washington, Idaho, Montana, Utah, Wyoming, Arizona, New Mexico, and Dakota, which were then territories. In 1891 its provisions were extended to Colorado. Desert lands are defined in the Act as "lands exclusive of timber lands which will not, without irrigation, produce some agricultural crop," and the determination of what may be considered desert land is left to the Commissioner of the General Land Office. Under the Act of August 30, 1890, the acreage which may be taken under this Act by one person was limited to 320 acres.

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[1] R. S. Sec. 2339.

[2] R. S. Sec. 2340.

The report of the General Land Office for the fiscal year ending June 30, 1914, shows the following acreages entered and patented. As only one-eighth of the land is required to be irrigated when patent is granted, it is probable that only a small part of the total acreage patented is actually irrigated.

DESERT LAND ENTRIES FROM THE PASSAGE OF THE ACT OF MARCH 3, 1877, TO JUNE 30, 1914

	Original Entries (Acres)	Patented (Acres)
Arizona	2,275,529.35	264,648.99
California	4,639,561.75	667,839.02
Colorado	3,111,116.23	490,391.27
Dakota Territory	20,021.00	300.00
Idaho	2,872,961.30	790,894.68
Montana	5,861,898.20	2,329,740.34
Nevada	476,764.68	69,280.25
New Mexico	2,109,553.00	194,169.92
North Dakota	85,118.51	18,791.75
Oregon	1,060,434.90	238,696.99
South Dakota	605,536.16	77,091.57
Utah	1,319,227.75	343,047.43
Washington	970,419.01	55,130.11
Wyoming	5,377,224.17	1,284,147.91
Total	30,785,366.01	6,824,170.23

Segregation of Reservoir Sites.—An Act approved October 2, 1888, provided for the investigation of the extent to which the arid region of the United States could be redeemed by irrigation, and the segregation of the irrigable lands in that region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation. It provided also that:

All the lands which may be hereafter designated or selected by such United States surveys for sites of reservoirs, ditches, or canals for irrigation purposes and all of the lands made susceptible of irrigation by such reservoirs, ditches, or canals, are from this time henceforth hereby reserved from sale as the property of the United States and shall not be subject after the passage of this Act to entry, settlement, or occupation until further provided by law; provided, that the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by the provision of this act to settlement under the homestead laws.

Extensive surveys were made under this law and there was a general withdrawal from entry of all the public lands in the arid region. This withdrawal was very unpopular, and an Act of August 30, 1890, repealed the part of the law providing for the withdrawal of public lands from entry, except that reservoir sites already segregated were to continue to be reserved from entry until otherwise provided by law, and reservoir sites thereafter located were to be reserved. By the Act of February 26, 1897, the reservoir sites segregated under the former law were made subject to applications under the Right of Way Act of March 3, 1891, referred to hereafter, and the states and territories in which the sites were located were authorized to improve and occupy them under the same conditions as individuals or private corporations. This Act provided also that the charges for water coming from such reservoir sites should be subject to the control of the states or territories in which they were located. Several reservoir sites were segregated under these laws, but in general they resulted in the reclamation of little if any land.

The Act of March 3, 1891, amending the Desert Land Act, provided also for the acquisition of rights of way over public lands or reservations for canals and ditches by canal or ditch companies prior to actual construction. Various acts relating to rights of way for irrigation were passed up to February 15, 1901, when a general act superseding the others was passed.

The Carey Act.—On August 18, 1894, Congress passed what is commonly called the Carey Act, the purpose of which, as expressed in the law, was "to aid the public-land states in the reclamation of the desert lands therein." This Act provided for granting to each of the states containing desert land, within the meaning of the Desert Land Act referred to above, such land, not exceeding 1,000,000 acres in each state, "as the state may cause to be irrigated, reclaimed, occupied, and not less than twenty acres of each one hundred and sixty acre tract cultivated by actual settlers, within ten years next after the passage of this Act, as thoroughly as is required of citizens who may enter under the said Desert Land Law." The states are required to file maps showing the mode of contemplated irrigation, and to show also the source of the water to be used, and on the approval of the maps and plans the lands applied for are segregated and reserved from entry. The states are authorized to enter into all contracts necessary for the reclamation of the segregated lands, but are prohibited from leasing any of the lands, from disposing of them in any way whatever except to secure their reclamation, cultivation, and settlement, and from disposing of more than 160 acres to any one person.

This law was amended by the Act of June 11, 1896, authorizing the states to create liens against the lands segregated for the purpose of reclamation, but providing that under no circumstances shall the United States be in any manner liable for any such lien.

The law was further amended on March 3, 1901, by extending the time for reclaiming segregated land to ten years from the date of segregation.

In 1908 an additional million acres was granted to the state of Wyoming, and an additional 2,000,000 acres to the state of Idaho.

By Act of February 18, 1909, the provisions of the Act were extended to New Mexico and Arizona.

The Act of March 15, 1910, provided for the temporary withdrawal from entry of lands for which applications under the Carey Act are to be submitted within one year.

It is apparent that this law is inoperative in any state until the state has accepted its terms and makes application for the segregation of lands. The states which have accepted the conditions of the Carey Act, with the dates of their original laws for this purpose are as follows:

Arizona	1912
Colorado	1895
Idaho	1895
Montana	1895
Nevada	1895
New Mexico	1909
Oregon	1901
South Dakota	1909
Utah	1897
Washington	1895
Wyoming	1895

The state laws governing operations under the Carey Act differ much in detail but are alike in general plan. All operations under the law are placed under the supervision of state boards, in some instances the existing state land boards and in other instances special boards created for this purpose. Any person or corporation desiring to reclaim land under this law applies to the proper board, specifying the lands which it is desired to have segregated, and describing the proposed plan of reclamation. The form of application and the information required to be furnished by applicants are prescribed by law and by the regulations of the boards, and by the regulations of the United States Department of the Interior. If approved by a state board, the application for segregation is submitted to the United States Department of the Interior, and the land is withdrawn from entry pending action. If the application is approved by the Department of the Interior the land is segregated and withdrawn from all forms of entry under the public-land laws. The state then enters into a contract with the applicant, providing for the construction of the proposed works by the applicant, and fixing the terms on which water rights may be sold to settlers on the lands. On its part, the state agrees to sell the lands only to parties who have entered into contract with the applicant for the purchase of water rights. The water rights sold must carry an interest in the works, so that when the payments for them are made the works and rights become the property of the water-right purchasers. Lands are usually sold for fifty cents per acre. Under the law, as soon as any state may furnish satisfactory proof that any of the lands are "irrigated, reclaimed, and occupied by actual settlers," patents are issued to the state, and the state in turn issues patents to the settlers when they have fulfilled the conditions imposed as to actual residence and improvement of the land and made the full payment of the purchase price of the land.

Under the amendment of June 11, 1896, the states are authorized to create liens on the lands "for the actual cost and necessary expense of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers," and for this purpose the Government may pass title to the state as soon as an adequate water supply is made permanently available. None of the states has provided for making the cost of the works a direct lien on the lands, but the states fix the prices at which water rights may be sold, and these rights are sold on deferred payments.

The notes given by settlers to secure these deferred payments are made liens on their interests in their lands, and contain provisions that the notes shall become liens on the lands themselves when title passes to the settlers. These notes are usually deposited with trustees as security for bond issues.

When Carey Act enterprises are completed and the lands and water rights are paid for, stock in new companies, to which the enterprises are turned over, is issued to the water-right holders, and the enterprises become coöperative.

State	Acreage		
	Applied for	Segregated	Patented
Colorado........	420,805.33	272,197.98	....
Idaho..........	3,235,900.23	1,305,764.67	247,164.71
Montana........	609,826.46	228,973.84	25,653.03
Nevada..........	180,005.85	36,808.59	....
New Mexico.....	10,164.68	7,564.68	....
Oregon..........	789,019.51	357,878.84	51,583.13
Utah............	606,704.00	141,814.94	....
Washington......	155,649.39	....	....
Wyoming........	1,674,369.88	1,341,226.47	135,653.36
Total.......	7,682,445.33	3,692,230.01	460,054.23

The areas applied for, segregated, and patented to the states under the Carey Act, up to June 30, 1914, as shown by the Report of the Commissioner of the General Land Office for 1914 are given in the preceding table.

The acreage reported irrigated under this Act in 1909, the acreage which Carey Act enterprises reported themselves capable of supplying with water in 1910, and the acreage included in these enterprises in 1910, are shown in the following table:

State	Acreage		
	Irrigated in 1909	Capable of Irrigating in 1910	Included in Enterprises
	485	6,085	59,480
Colorado	162,418	742,618	1,098,661
Idaho	9,648	49,500	306,997
Montana	....	....	16,000
New Mexico	24,750	65,500	623,264
Oregon	5,000	20,000	43,000
Utah	86,252	205,974	426,472
Wyoming			
Total	288,553	1,089,677	2,573,874

United States Reclamation Law.—The Act of Congress approved June 17, 1902, known as the Reclamation Law, provided for the first time for the construction of irrigation works outside of Indian reservations, directly by the Federal Government. This Act set aside the receipts from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming as a "reclamation fund" to be used in the examination and survey for, and the construction and maintenance of irrigation works, and for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands.

The plan of work outlined in the law includes the withdrawal from all forms of entry, except under the Homestead Law, of tracts of public lands, for examination as to the feasibility of their irrigation, for surveys and estimates, and for the construction and operation of works. Originally entrymen on these lands were required to repay to the Government the cost of providing a water supply in not more than ten annual payments, without interest on deferred payments, but this time has been extended to twenty years. Entries may be limited to forty acres by order of the Secretary of the Interior, and the commutation clause of the Homestead Act does not apply to these lands—that is, the entryman must reside on the land five years before title can be secured. In 1912 the required period of residence was reduced to three years. He must also repay to the Government the amount of the cost of the water supply apportioned against his land, before securing title.

When the payments required by the Act are made for the major portion of the lands irrigated from the waters supplied by any project, the operation and management of the works are to pass to the owners of the lands irrigated, to be maintained by them under some form of organization acceptable to the Secretary of the Interior. But the title to these works and their management and operation are to remain in the Government until otherwise provided by Congress (see page 149).

The Act provides that the work shall be done in accordance with state laws. It originally provided, also, that the major portion of the funds arising from the sale of lands in each state should be spent within that state, but this provision has been repealed. While the Act apparently relates principally to public lands, it is provided that lands in private ownership may be supplied with water, and in fact some projects include no public lands.

This work was originally assigned to the United States Geological Survey, and the Reclamation Service was organized as a division of that bureau. It was later made an independent bureau of the Department of the Interior.

The law was made to apply to the receipts from the sale and disposal of lands from the beginning of the fiscal year ending June 30, 1901, and the amount covered into the treasury to the credit of the reclamation fund up to June 30, 1914, from the several states, is as shown in the following table, taken from the Fifteenth Annual Report of the U. S. Reclamation Service (1914).

TOTAL ESTIMATED RECEIPTS TO RECLAMATION FUND TO JUNE 30, 1914

State	Amount
Arizona	$1,241,696.88
California	5,620,943.03
Colorado	6,957,991.93
Idaho	5,212,408.90
Kansas	975,080.07
Montana	9,565,107.48
Nebraska	1,759,613.83
Nevada	573,596.96
New Mexico	4,116,790.95
North Dakota	12,025,398.43
Oklahoma	5,813,357.84
Oregon	10,550,928.22
South Dakota	6,999,178.66
Utah	1,939,479.34
Washington	6,555,299.73
Wyoming	4,522,900.46
Total	$84,429,772.71

The agricultural results of operations under the Reclamation Law to June 30, 1914, as shown by the same report, are summarized in the table on page 71.

United States Indian Service.—At various times Congress has provided for the construction of irrigation works on Indian reservations. Some of these have been paid for from tribal funds, and some from direct appropriations.

SUMMARY OF AGRICULTURAL RESULTS OF RECLAMATION LAW TO JUNE 30, 1914

Projects	Acreage Irrigated in 1913	Acreage Service Could Have Supplied in 1914	Estimated Total Acreage in Project
Arizona: Salt River	163,312	182,000	182,000
Arizona-California: Yuma	19,607	58,000	158,000
California: Orland	6,617	14,307	20,000
Colorado:			
Grand Valley	....	....	53,000
Uncompahgre	31,428	58,000	140,000
Idaho:			
Boise	58,265	207,000	207,000
Minidoka	75,957	116,400	120,500
Montana:			
Blackfeet	....	26,649	122,500
Flathead	4,631	48,400	152,000
Fort Peck	410	10,220	152,000
Huntley	15,798	28,808	32,408
Milk River	2,545	14,000	219,557
Sun River	7,419	16,346	174,046
Montana-N. Dakota: Lower Yellowstone	7,660	40,541	60,116
Nebraska-Wyoming: North Platte	56,829	109,500	129,270
Nevada: Truckee-Carson	43,075	52,039	206,000
New Mexico:			
Carlsbad	14,260	20,261	20,261
Hondo	932	....	10,000
Rio Grande	27,723	40,000	155,000
North Dakota:			
Buford-Trenton	....	4,050	15,025
Williston	1,739	8,189	11,289
Oklahoma: Lawton	....	....	2,500
Oregon:			
Klamath	18,928	35,400	70,600
Umatilla	4,994	17,587	36,300
S. Dakota: Belle Fourche	32,881	68,852	100,000
Utah: Strawberry	....	....	50,000
Washington:			
Okanogan	7,700	10,099	10,099
Sunnyside	58,300	81,306	102,824
Tieton	18,750	34,071	34,071
Wyoming: Shoshone	19,423	41,168	164,122
Total	699,183	1,343,193	2,910,488

This work is confined to Indian reservations, and is for the benefit of the Indians. The following table shows acreage, etc., by states.

State	Acreage Irrigated in 1909	Acreage Capable of Irrigating in 1910	Acreage Included in Enterprises
Arizona..........	19,386	20,974	36,017
California........	3,490	3,490	3,800
Colorado.........	1,020	2,020	20,020
Idaho............	3,426	21,540	51,540
Montana.........	67,417	114,340	440,940
Nebraska.........	300	300	600
Nevada..........	2,597	3,381	18,060
New Mexico......	24,007	24,743	37,455
Oregon...........	429	439	879
South Dakota....	50	50	100
Utah.............	11,520	86,600	106,000
Washington......	35,000	50,000	100,000
Wyoming.........	4,270	48,699	63,657
Total.......	172,912	376,576	879,068

STATE LEGISLATION

As stated previously, in the sense that the states have control over diversions from non-navigable streams, all irrigation is done under state laws. All the states in the arid region have some legislation regulating the diversion and use of water from streams and other sources, and most of them have some legislation intended to assist directly in the construction and operation of irrigation works. In three states—Colorado, Montana, and Utah—

there has been some construction by the states themselves, but in no case has this state construction resulted in the reclamation of any appreciable area of land.

The state of Colorado attempted to utilize its convict labor in the construction of canals and reservoirs, and considerable work was done, but the policy was abandoned and the works turned over to other agencies.

Montana undertook to reclaim the lands granted to it under the Carey Act, and several projects were begun. This policy was abandoned, however, and the Carey Act lands are now handled in Montana in the same manner as in the other states.

The state of Utah created in 1897 a reservoir fund from the receipts of sales of lands granted to the state for the purpose of constructing reservoirs, and at one time engaged in the construction of a few reservoirs. More recently these funds are loaned to aid in the construction of reservoirs by private agencies.

Irrigation Districts.—Most of the states have attempted to aid irrigation development by delegating to communities a part of the functions of the state—the levying and collecting of taxes—to raise funds for the construction or purchase of irrigation works and for their maintenance and operation. The communities organized for these purposes are known as irrigation districts; in some states as "municipal irrigation districts." The laws of the several states providing for the organization of irrigation districts are similar in their general outlines but differ in many important particulars. In general they provide that lands susceptible of irrigation from a common source may be formed into an irrigation district for the purpose of providing a water supply for their irrigation. The organization of a district is initiated on petition of the owners of the land proposed to be included in the district. Under most of the laws, this petition goes to the county commissioners. Hearings are held and then an election to pass on the question of organization. The votes required to carry the organization of districts vary from a majority to two-thirds. Districts have authority to issue bonds for the purpose of obtaining funds for the construction or purchase of irrigation works; and to levy and collect taxes for the payment of interest and principal of bond issues, and the expenses of operation and maintenance. These taxes are made a lien on the lands, in the same manner as state and county taxes generally.

Utah was a pioneer in this field, as in many others, the first irrigation district law being approved January 20, 1865. This law was in general the same as the present-day laws, except that districts were not authorized to issue bonds. They did, however, levy and collect taxes. At one time or another a large part of the irrigated land in Utah has been included in districts. These districts were short-lived, however. The law was repealed in 1897, with a proviso that districts already organized might continue to operate under its provisions. A new district law was enacted in 1909, which will be discussed later.

The California district law, known as the Wright Act, passed in 1887, was the first to include the bonding privilege. This has served as a model for the district laws which have been enacted since that time in all of the arid and semi-arid states except North Dakota, South Dakota, and Oklahoma.

The primary object of this form of organization is the obtaining of funds for the purchase or construction of works to supply water for irrigation, and for this purpose districts are authorized to issue bonds. These bonds are a lien on the land, and lands may be sold to satisfy this lien in the same manner as for any other tax lien. Most of the laws make county treasurers *ex-officio* treasurers of districts, and provide for the levy and collection of district taxes by county treasurers if district boards refuse or neglect to do this.

All of the district laws contain restrictions on the prices at which bonds may be sold, but they contain also provisions that bonds may be used in payment for works already built or for materials and labor. The latter provision nullifies the former for the reason that when bonds are used in direct payment, prices are fixed according to the discount at which contractors will take the bonds. In fact, this practice prevails. The limitations on prices do not bind contractors who may dispose of bonds at any figure.

District laws have for another object the forcing of all land within the district to contribute to the cost of works which add greatly to its value whether water is received or not. There is always an element in every community which stands back and takes the benefit of improvements without contributing to their cost, and this is peculiarly true in irrigated sections. The possibility of obtaining water adds greatly to the value of lands, but, except under district laws, land owners cannot be forced to contribute to the cost of ditches which give value to their lands. Under district laws all lands susceptible of irrigation from the works of any district may be included in the district and taxed for district purposes. This tends to force development, since land owners cannot long afford to pay district taxes on unimproved land. In the western states the unimproved lands which have passed from the public domain are largely owned by non-residents and it is probable that the compelling of these nonresident land owners to contribute to the cost of developing the country was one of the principal motives behind the passage of irrigation district laws.

It has been stated that the original district law in Utah was not a great success. In California a large number of districts were organized under the original law of 1887, but most of these districts failed. Large areas belonging to parties who were opposed to irrigating were forced into districts, and the owners of these lands fought the districts in which they were included at every step, attacking the validity of their organization and of their bond issues. This led to endless litigation and destroyed the market for the bonds. Districts which survived this suffered from poor management and wasteful expenditures, so that very little was accomplished under this law. A few districts have lived through all these adversities and are finally, after more than twenty years, operating successfully and meeting their obligations. The report of the eleventh census (1890) shows that in 1893 fifty irrigation districts had been organized in California. These districts included 2,285,000 acres, had voted about $17,000,000 worth of bonds, and had disposed of about $6,000,000 worth of these bonds. The thirteenth census (1910) shows but twelve districts in actual operation in California. These include 606,351 acres, were ready to supply water to 294,108 acres in 1910, and actually irrigated 173,793 acres in 1909. While the immediate causes of failure were as pointed out above, it is probable that the fundamental cause in some cases was the possibility of growing crops without irrigation. In these districts, the persons who were most active in opposing the districts were the owners of large tracts devoted to wheat raising without irrigation, and it seems probable that if their lands had been worthless without irrigation their attitude would have been different. Since 1911 an attempt has been made in California to revive development by irrigation districts, by supervising their organization and providing for state certification of their bonds. This has been partially successful. It is discussed more fully in another chapter (page 120).

District laws have been moderately successful in some other states. Idaho enacted a district law in 1895, and the thirteenth census shows eleven districts in successful operation. These irrigated 140,930 acres in 1909, were capable of supplying water to 177,900 acres in 1910, and included 329,796 acres within their boundaries. Two other districts were reported organized but were not ready to supply water in 1910. Nebraska and Colorado also have several successful districts. The following table shows the years in which district laws

State	Date of Original District Law	Acreage Irrigated in 1909	Acreage Enterprises Were Capable of Irrigating in 1910	Acreage Included in Projects
Arizona	1912	....	....	....
California	1887	173,793	294,108	606,351
Colorado	1901	115,304	207,570	487,370
Idaho	1895	140,930	177,900	329,796
Kansas	1891	....	....	....
Montana	1907	412	6,640	6,640
Nebraska	1895	76,448	77,228	91,076
Nevada	1891	....	....	....
New Mexico	1909	....	....	16,400
Oregon	1895	1,500	1,500	5,980
Texas	1905	....	....	....
Utah	1865	8,455	8,455	10,802
Washington	1890	....	....	....
Wyoming	1907	11,800	27,050	27,050
Total		528,642	800,451	1,581,465

were enacted in the various states, the area included in districts in 1910, the area which these districts were capable of supplying with water in 1910, and the area irrigated in 1909.

Since 1910 there has been considerable activity in the purchase of existing canal systems by districts organized for that purpose in Texas.

General State Laws Relating to Irrigation.—Of the total acreage irrigated in 1909 only 10.1 per cent. was supplied with water under the state and Federal laws treated in the preceding sections. The remainder of the land irrigated (practically ninety per cent. of the total) was served by works controlled by individuals or organizations operating under the general irrigation laws of the states. These laws are of two general classes—those dealing with the rights to water and those dealing with the construction and operation of ditches.

The law of water rights in the arid region is not well worked out, for the reason that it is still in its formative period, where legislatures and courts are constantly making changes and new interpretations in an attempt to adapt legal conceptions to changing physical conditions; and for the further reason that the arid region of the United States is the meeting place of the English common law, developed in humid regions and brought into the West from the East, and the civil law developed in arid regions and brought from the South. The law of water rights is further complicated by the fact that it deals with intangible rights, rather than tangible goods, and these rights relate to the use of an uncertain, unstable, transitory thing which must be used as it passes, which use only partially consumes, which cannot be stored for future use except within narrow time limits, and which is exposed at all times and throughout long distances to appropriation by persons having no rights to its use.

The diversion and use of water from the streams of the arid region for mining and agricultural purposes began in some sections before the establishment of civil government, and in most of the arid region before the enactment of any laws relating to irrigation; and, speaking generally, irrigation legislation has resulted from attempts to put into the form of law practices already in existence, while court decrees have been a strange mixture of common practice in the arid region and legal precedent developed in humid regions.

In a humid region water for the maintenance of animal and plant life is plentiful; the highest use of the water in streams requires that it remain in the stream for navigation and power, and rights to its use belong naturally to those who have access to the streams—the owners of abutting land. Thus the fundamental idea of the English common law of waters is that the right to use the water of streams attaches to lands abutting on the streams—the riparian doctrine.

In an arid region the very existence of human habitation depends on the use of the water of streams for domestic purposes and irrigation, and consequently laws developed in arid regions provide for the diversion of water from streams without reference to where it is used. Under the civil law, which developed in an arid region, water belongs to the crown, and rights to its use are obtained by grant.

As already stated, irrigation began in the arid region of the United States before the existence of any established government. Here the law of necessity governed, and men diverted and used the water of streams without reference to ownership of land, and there grew up the American doctrine of "appropriation." Under this doctrine anyone who will put water to a "beneficial use" may take or "appropriate" it, and the right to continue to take it exists so long as the use continues, provided such use does not conflict with use by one who made an earlier appropriation from the same source. "First in time, first in right," is the classical statement of this doctrine.

The water-right laws of the arid region are a conglomerate of these three doctrines.

The common law of riparian rights, modified to a considerable extent by judicial decisions and state legislation, is recognized in California, Kansas, Oregon, and Washington, and this modified form of the riparian doctrine is commonly called the "California" doctrine, because it was first stated by the courts of that state.

The civil law doctrine, that the water of streams belongs to the state, was embodied in the constitution of Wyoming when that state was admitted to the Union in 1890, in the following language:

> The water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are hereby declared to be the property of the state—Art. VIII, Sec. 1.
>
> Priority of appropriation for beneficial uses shall give the better right. No appropriation shall be denied except when such denial is demanded by the public interests.—Art. VIII, Sec. 2.

Because this doctrine found its first formal statement in the United States in the Wyoming constitution, it is sometimes called the "Wyoming" doctrine. Similar declaration is made in the laws of Idaho, Nevada, and Texas.

The doctrine of appropriation, that the water of streams belongs to the public, was embodied in the constitution of Colorado, in 1876, the language being as follows:

The water of every natural stream, not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation, as hereinafter provided.—Art. XVI, Sec. 5.

The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better rights as between those using water for the same purpose.—Art. XVI, Sec. 6.

This doctrine is commonly called the "Colorado" doctrine, and is the most commonly accepted theory as to water rights in the arid region. The states whose water laws declare that water is the property of the public are Colorado, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Utah. Several of the states make no formal declaration on this subject.

The distinction between the Wyoming and Colorado systems appears principally in the laws relating to the acquisition and defining of water rights. Under the Colorado system rights are in theory acquired by appropriation and use under state regulations designed to provide a record of rights. Under the Wyoming system rights are in theory acquired by grant from the state. Under the Colorado system rights are not defined as they are acquired, but only as they come into controversy, when they are defined by the courts. Under the Wyoming system rights are defined as they are acquired, and those acquired before the enactment of the present laws are defined by administrative boards. The distinctions just made are not always clearly maintained, however, and the laws of some of the states contain elements of all three of the doctrines mentioned.

The larger part of state legislation relating to irrigation deals with the acquisition of rights, the defining of rights, and the enforcement of rights. As many rights to water were acquired before the enactment of any legislation on this subject, these rights were not defined either as to nature or extent as they were acquired. Consequently much legislation providing for the defining of rights has been enacted. Water rights are of such a nature that it is practically impossible for an individual to protect his own rights, and most of the states have provided by law for this also. The laws relating to these points are summarized below:

Acquisition of Rights.—Water rights were originally acquired by appropriation and use, without formalities of any kind, and many rights still rest on no other basis. The first step beyond this was the posting at the points of diversion of notices stating what was claimed and the filing of copies of these notices with some public official, usually the county recorder or county clerk. At present (1914) no other formalities are required in Arizona, Kansas, Montana, and Washington. In order that rights may be acquired, this posting and filing must be followed by construction of works and use of water, and these states make no provision for making any record of this construction and use, rendering the record of claims practically worthless as an index of existing rights. Colorado has gone a little further, and requires the filing of claims with maps and certain information with the state engineer, bringing all claims in the state into a single office. As in the other states, however, there is no provision for records of appropriation and use, making the records useless as an index to existing rights.

The Wyoming system of initiating rights by applying to the state for permission to appropriate and use water has been adopted by California, Idaho, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, and Wyoming. The permits approved fix the time within which the works provided for must be completed, and the water be put to use, and the laws provide for the submission of proof of having complied with the conditions of the permits, and for the issuing of certificates showing what rights have been acquired. If enforced, these laws provide a complete list of rights acquired since their enactment. The oldest of these laws is that of Wyoming, enacted in 1890, while some of the others have been in force but a few years, so that they affect only a small part of the rights within the states named, as shown by the table at the end of this discussion.

Definition of Rights.—The defining of rights not defined as they are acquired is left to the courts in Arizona, California, Colorado, Idaho, Kansas, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, and Washington. Rights are defined by administrative boards in Wyoming and Nebraska. Most of the states in which water rights are adjudicated by the courts have laws providing that when any action regarding water rights is brought, all parties claiming rights to water from the same source shall be made parties to the action, so that all rights may be determined in a single action. Several states—California, Idaho, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, and Utah—have provisions for the collecting of information and the making of surveys by the state engineer or some state board in connection with adjudications, in order that the courts may not be wholly dependent upon the testimony of interested parties; and three of them—New Mexico, North Dakota, and South Dakota—provide for the initiation of such actions by the attorney-general of the state on application by the state engineer.

The following table shows the percentages of the land irrigated in 1909 supplied with water under the several kinds of rights just discussed, as shown by the census report. The clerks who made the tabulations were instructed to classify

State	Per Cent. Which Acreage Irrigated Under Specified Form of Water Rights Represented of Total: 1909					
	Riparian Rights	Appropriation and Use	Notice filed and Posted	Adjudicated	Permit from State	Certificate from State
Arizona	0.2	76.7	14.7	8.4	(1)	(1)
California	8.2	47.3	16.6	28.0	....	....
Colorado	(1)	9.3	5.1	84.4	(2)	(2)
Idaho	0.1	18.9	25.4	36.9	17.6	0.1
Kansas	0.1	73.6	26.3	....	....	....
Montana	....	15.0	44.4	38.0	(2)	(2)
Nebraska	....	8.8	9.9	18.8	59.6	2.7
Nevada	(1)	86.9	5.4	1.4	1.4	4.8
New Mexico	0.1	83.9	2.2	5.6	8.0	0.1
North Dakota	....	88.9	6.8	....	4.3	....
Oklahoma	....	77.4	5.4	17.1	....	....
Oregon	3.5	58.3	29.0	5.4	3.8	....
South Dakota	3.6	21.2	35.0	14.8	7.4	17.5
Texas[3]	11.7	70.8	5.9	....	(2)	(2)
Utah	(1)	51.5	6.2	35.1	3.9	3.2
Washington	5.2	54.5	29.3	7.6	(2)	(2)
Wyoming	0.2	8.5	0.8	4.3	28.3	57.9
Total	2.1	34.0	16.2	35.3	6.7	5.7

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[1] Less than one-tenth of 1 per cent.

[2] Small areas erroneously reported as in this class. State issues no permit or certificate.

[3] Exclusive of land irrigated for rice growing.

under "appropriation and use" all lands for which the class of rights was not reported, and it is possible that the percentage for this class is slightly too high. It seems probable, however, that most persons having evidence of title to water rights would know what it is and would report it. It is evident that there are slight errors in the classification, as rights of the various classes are reported in states where such rights do not exist, such as "permit from state," and "certificate from state" in Montana, Texas, and Washington.

Colorado ranks first in percentage of rights actually defined, with 84.4 per cent. adjudicated. Wyoming ranks second, with about 62 per cent. represented by adjudications and certificates from the state, with 28.3 per cent. represented by permits for which final proof had not yet been made. Montana ranks third in actual adjudication, with 38 per cent., although Nebraska and Idaho have much higher percentages, if rights represented by permits for which final proof has not been made are included. These figures relate to the year 1910, and it is probable that the percentage of defined rights has increased considerably since that time.

Distribution of Water.—Several of the states have provided for the distribution of water by public officials. Colorado was the first state to provide for this, and its system has been adopted by the other states. For the distribution of water the state is divided into five divisions, and each of these is subdivided into districts. For each district there is a water commissioner, who has direct control of the distribution of water within his district. He is supplied with a list of all defined rights, and each day gets reports of the volume of water within his district available for supplying these rights. He then issues his orders to ditch owners, telling each how much water he may take, or goes over the stream in person or by deputy and sets all diversion gates to deliver the proper volumes of water. Ditch owners are required to install measuring devices in their ditches, and there are severe penalties for changing gates which have been set by a water commissioner.

Anyone dissatisfied with the decisions of a commissioner may appeal to the division engineer, from him to the state engineer, and then to the courts.

This system has been adopted in Wyoming, Nebraska, Idaho, Utah, Nevada, North Dakota, South Dakota, New Mexico, Oklahoma, and Oregon, although it has not been put into operation in some of the semi-arid states, on account of the limited call for the services of commissioners. In Washington each county is considered a water district, and water commissioners may be appointed by the county commissioners when necessary. In Montana courts rendering decrees defining rights to water appoint commissioners to enforce their decrees, on petition of the owners of one-fourth of the rights. In Kansas the law provides for water bailiffs appointed by the courts. In California the state board may distribute water if this does not interfere with the courts.

Laws Promoting Irrigation.—The material development of the arid states is so largely dependent upon irrigation that most of the states have encouraged it in every way possible. In a few states irrigation works are exempt from taxation. By the constitutions of Colorado and Utah, ditches, canals, and flumes owned and used by individuals or corporations, or the individual members of the corporations, are not taxed separately so long as they are so used exclusively. Works used to convey water for hire are taxed, however. Arizona has a similar statutory provision. Under these provisions the works belonging to individual, partnership, and coöperative enterprises are exempt. As these enterprises supply about ninety per cent. of all the land irrigated, it is evident that most irrigation works in these states are exempt from taxation.

In all of the arid and semi-arid states ditch owners are given the right to condemn rights of way over land of others for bringing water to their lands. In most of the states a special procedure is provided, differing only slightly from other laws providing for condemning private property for public use. In several of the states, but not in all, this right is based on constitutional or statutory declarations that the use of water for irrigation is a public use. The Idaho constitution makes the use of land for a right of way for an irrigation ditch a public use. The California constitution makes use only for "sale, rental, or distribution" a public use, leaving use by the individual through his own ditch a private use. The Montana constitution extends its provisions to "other beneficial use," while the Washington constitution makes the general statement that the use of water for irrigation is a public use. The declaration of public use has been the basis of laws providing for the regulation of rates to be charged for water supplied for hire, as well as for condemning rights of way.

The Federal law of 1866 recognizing local laws, customs, and decisions, previously referred to, and an amendment to that law in 1870, extend this privilege of conveying water over the lands of others to public lands. The clauses of these laws relating to rights of way are as follows: "And the right of way for the construction of ditches and canals for the purposes herein specified (mining, agricultural, manufacturing or other purposes) is acknowledged and confirmed;" and "All patents granted, or pre-emptions or homesteads allowed, shall be subject to any vested and accrued water rights, or rights to ditches and reservoirs used in connection with such water rights, as may have been acquired under or recognized by the preceding section."

Irrigation district laws for promoting irrigation have already been discussed.

CHAPTER VII

IRRIGATION INVESTMENTS

IRRIGATION SECURITIES

The reclaiming of land by irrigation on any considerable scale requires the investment of large sums of money before there can be any return from the lands, since the works for bringing the water to the land must be built before crops can be grown. This initial investment, as shown by the last census, averages $15.92 per acre, while under many of the large enterprises recently carried out, it exceeds $50 per acre on the land to be reclaimed.

Sale of Stock.—In the early days of construction of irrigation works on a large scale, the usual method of raising funds was the sale of stock. The great increase in the value of desert lands when water was provided made this form of investment look very attractive, as it was figured that the canal company could appropriate to itself this increase in values. This could not be done directly, as most of the land belonged to the Federal Government, and could be acquired by actual settlers only, but it was thought that it could be done by selling water rights to the settlers, who would be unable to maintain themselves on the land without the water to be furnished by the canal. This scheme did not work out, however, for the reason that the settlers did not come as rapidly as was expected, and those who did come were not forced to purchase rights. They might not be able to reclaim their lands without the water, but they could stay away or refuse to purchase rights, both of which they did. As a result most of such enterprises were failures, and investments of this kind became unpopular.

This plan had two especially weak features: it depended on the settlement of the land, and there was no way in which the land could be made security for deferred payments on water rights, since the title was in the Federal Government. It had the advantage that if an enterprise succeeded, the capitalist who had purchased stock participated in the profits resulting from this success. The fundamental mistake of the investors in this class of irrigation enterprises seems to have been that they considered them short-time investments in which they would turn their money over within a few years whereas they are of necessity long-time investments. As was stated, construction must precede settlement, and the settling of the land is a matter of years, not months; in the meantime interest and maintenance charges continue without a break. If this had been taken into account and plans laid and prices fixed accordingly, then there is little doubt that such enterprises could have been made to succeed. But those entering upon such enterprises must expect to carry them for twenty years or more before realizing on their investments, and must figure on returns from only a part of the lands (see page 226). At the present time there are few companies operating on this plan, the prevailing scheme for raising funds for irrigation construction being the sale of bonds.

Sale of Bonds.—The first plan for raising funds for irrigation construction by the sale of bonds, and one which is just now perhaps the most popular, is the organization of "irrigation districts." The first district law was that of Utah, enacted in 1865, but this did not provide for the issuing of bonds. It merely permitted the people of a district to tax their property to raise the funds for providing themselves with a water supply. The original district law containing the bonding provision was that of California, enacted in 1887, and known as the Wright Law. Since that date irrigation district laws have been adopted in most of the arid states. The fundamental features of these laws, from a financial point of view, are the same. Funds are raised by the sale of bonds which are liens on the lands included in the districts, and interest and sinking funds are raised by taxation of the property subject to the liens. The laws of the several states differ as to the qualifications of the electors who are to decide upon the organization of districts, the vote required to carry the organization or the issue of bonds, the property subject to lien, and in other details. Many of these provisions affect the value of the bonds and their salability, and consequently should be included in a discussion of the financing of irrigation enterprises.

Probably the greatest weakness of the California district law was the provision allowing equal representation to all property owners, regardless of the size of their holdings. This provision made it possible for the owners of a small part of the property in a proposed district to carry elections for organization and for bond issues, thus forcing the organization upon the owners of large holdings. The owners of these large holdings tried in every way to defeat the district organizations and bond issue, and carried the fight into the courts. Although most of the districts were finally declared legally organized, the constant litigation made investors look with disfavor on the bonds issued by the districts. Many districts were killed in this way even after they had been legally organized. Some have persisted and are finally meeting their obligations, and others have made settlements of various kinds with the bond holders, but in general the market for California district bonds is not good.

One of the arguments in favor of the district laws has been that it is possible to make the owners of the large holdings and non-resident holders contribute to the building up of the country instead of waiting for the improvement of the country by others and taking the "unearned increment." This, however, has proven to be one of the great sources of weakness in the district laws, since it makes possible the organization of districts containing large elements hostile to the districts, which are able to defeat the purposes of the districts by creating distrust of their bond issues. Since the sale of bonds is the only reason for the existence of the districts, the prevention of sales defeats the whole purpose of the law.

The legislatures of the arid states have recognized this weakness, and have gradually given up the idea of exploiting large holders and non-resident owners, and some of the most recent laws provide for representation in proportion to area, and for the representation of non-residents. The present-day idea seems to be to make it more difficult to organize districts, in the hope that they will be more successful when organized. The provisions looking to that end are as follows:

Arizona: The petition for organization must be signed by fifty or a majority of the property owners in the proposed district. All qualified electors who have been owners of land within the proposed district for at least six months prior to the election, and are residents of the state, may vote on district matters, and bona fide claimants on public lands are considered owners for this purpose. A majority vote carries both organization and bond elections.

California: The petition for the organization must be signed by a majority of the holders of title to lands susceptible of irrigation by proposed works, who must also represent a majority of the assessed value of such lands according to the last county assessment roll. A two-thirds vote is necessary to carry the organization of a district, and a majority vote of qualified electors is necessary to carry a bond election. The right to vote is restricted, however, to qualified electors under the general election laws of the state.

Colorado: The petition for organization must be signed by a majority of resident freeholders owning, in the aggregate, a majority of the whole number of acres belonging to resident freeholders in the proposed district. Persons who are resident freeholders of agricultural lands within the proposed district, and non-resident owners of land to the extent of forty acres within the district who reside in any county into which the district extends and who are qualified electors of the state, may vote on organization and bond issues. A majority vote only is required to carry either the organization or bond issue.

Idaho: The petition for organization must be signed by fifty or more or a majority of the holders of titles to lands susceptible of irrigation by proposed works, who must hold title to at least one-fourth of the total of the lands which would be assessed by the district. Entrymen on Federal or state land may sign the petition, and their lands shall be considered as owned for this purpose. All holders of land within the district who are over twenty-one years of age, citizens of the United States, and residents of the state may vote, having one vote for each "inch" of water they are entitled to use, or, until the works are in operation, one vote for each acre of land owned. A two-thirds vote is necessary to carry either organization or bond issue.

Kansas: Petition for organization must be signed by three-fifths of the resident land owners of the proposed district, and a three-fifths vote is necessary to carry either organization or bond issue.

Montana: Petition for organization must be signed by a majority in number of holders of title to land susceptible of irrigation by proposed works, who must also represent a majority in acreage of such lands. Purchasers of state land who have not yet received title are considered owners for this purpose. Petition is presented to the district court and is passed upon by the court without any election, and the court appoints the first board of commissioners. After that they are elected, the right to vote being extended to holders of title to land in the district who are (1) qualified electors; (2) guardians, executors, administrators, and trustees; (3) domestic corporations by their authorized agents. Each elector is entitled to one vote for each forty acres of land, or fraction thereof owned, but any elector owning twenty acres or less is entitled to one vote. Bonds are issued by the district board on petition of a majority in number and acreage of the holders of the title. Orders of the board providing for the issue of bonds must be referred to the district court, with appeal to the Supreme Court of the state.

Nebraska: Petition for organization must be signed by a majority of the electors owning land or holding leasehold estates in proposed districts, who must also own or hold a majority of the number of acres in the district. Majority vote carries organization and bond issues.

Nevada: Petition must be signed by a majority of the taxpayers owning lands susceptible of irrigation from the proposed works. A majority vote of the "freeholders who are also qualified electors of the district" is necessary to carry organization and a two-thirds vote to carry bond issues.

New Mexico: Petition for organization must be signed by a majority of the resident freeholders, owning more than one-half the lands. Two-thirds vote is required to carry organization and a majority vote carries bond issues. Voters are qualified electors in the precinct who are resident freeholders.

Oregon: Petition for organization must be signed by fifty or a majority of the freeholders of title to lands in the proposed district. A three-fifths vote is required to carry organizations, and a majority vote to carry bond issues. All bona fide land owners, male or female, of the age of twenty-one years or over, whether residents of the district or not, may vote. A corporation owning land may vote as a single individual, and *bona fide* claimants on Federal or state lands are considered owners for district purposes.

Texas: Petition must be signed by a majority of holders of title to lands susceptible of irrigation from the proposed works, representing a majority in value according to county assessment roll. A two-thirds vote is necessary to carry organization and bond issues. Voters must be qualified electors under general election laws, and resident property tax payers in the district.

Utah: Petition for organization must be signed by a majority of land owners in the proposed district, who are also owners in the aggregate of a majority of the whole number of acres in the proposed district. All persons and corporations who own agricultural land within the proposed district are entitled to vote, having one vote for each acre. A majority vote carries the organization, and a two-thirds vote carries bond issues.

Washington: Fifty or a majority of holders of title or evidence of title to lands susceptible of organization from the proposed works must sign petition for organization. Any person of the age of twenty-one years, who is a citizen of the United States, has been a resident for ninety days of the county in which any of the lands of the district are located, and who holds title or evidence of title to land in the district is entitled to vote on organization and bond issues. A two-thirds vote is necessary to carry organization, and a majority vote to carry bond issues.

Wyoming: Petition must be signed by a majority of freeholders holding title to land in the proposed district. Any person who is a citizen of the United States or has declared his or her intention to become such, and who owns lands in the proposed district, is allowed to vote on organization and bond issues. A majority vote is required to carry both organization and bond issues.

It will be seen that in seven of the fourteen states having district laws—California, Colorado, Montana, Nebraska, New Mexico, Texas and Utah—those signing petitions for organization must represent a majority, either in acreage or assessed value, of the land to be included in the proposed districts. In seven of the states—California, Idaho, Kansas, New Mexico, Oregon, Texas, and Washington—more than a majority vote is required to carry the organization of districts. In five of the states—Idaho, Kansas, Nevada, Texas and Utah—more than a majority vote is required to carry a bond issue. Four states—Arizona, Colorado, Nebraska, and Wyoming—require no more than a majority in favor of organization or bond issues at any stage. Wyoming has the most liberal law regarding the qualification of electors, allowing any citizen of the United States or person who has declared his or her intention to become such, and who owns land in the proposed district, to sign the petition and to vote. In his report for 1910, the state engineer of Wyoming says of this law: "The district law is very imperfect. As it stands it is a great inducement to speculators;" and again: "It had better be repealed than to stand in the present condition."[1]

The provisions just discussed have nothing to do directly with the validity of bond issues, but they do affect the sale of bonds to careful investors, and, therefore, have an important bearing on the financing of irrigation enterprises, since they indicate to a degree the sentiment of the land owners toward the districts in which their lands are included.

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[1] State Engineer's Report, Wyoming, 1910, pp. 119 and 121.

The sale of irrigation district bonds depends more directly on the security behind them, and this differs in the several states. In all states the bonds are a lien on the lands of the district, but the property included in the lien differs.

Arizona makes district taxes apply to "the real property of the district," and all lands are taxed at the same rate per acre.

In California assessments are levied on "all real property of the district," but improvements on lands and town lots are exempt. All property is to be assessed at its full cash value.

In Colorado assessments cover all real property exclusive of improvements, and all land is to be valued at the same rate per acre. No land is to be taxed which from natural causes cannot be irrigated or is incapable of cultivation.

In Idaho all the land in a district is subject to district taxes, and taxes are to be apportioned on the land in proportion to the benefits received.

In Kansas assessments are to be made on all "real estate which shall be dependent for irrigation upon the works so constructed or purchased," but the basis of the assessment is not specified by law.

In Montana assessments cover all the land in the district, at a flat rate per acre, for both operation and bonds.

In Nebraska no lands which cannot be benefited are included in districts. Assessments are levied on all real property in districts, including lands and city lots, at full cash value, less the value of all improvements.

In Nevada all real property in the district is subject to assessment at its full cash value.

In New Mexico all real property in the district is assessed, but no land is taxed which cannot be irrigated by the system. All land is assessed at a uniform rate per acre.

In Oregon all land in the district is to be assessed at a uniform rate per acre.

In Texas assessments are made on all property in the district, both real, personal, and mixed, and all is assessed at full value.

In Utah assessments are levied on all real property of the district, exclusive of improvements, but land which from natural causes cannot be irrigated is not liable to assessment. All lands are assessed at a flat rate per acre.

In Washington assessments are levied on all land of the district in proportion to the benefits accruing.

In Wyoming assessments are levied on all real property of the district, exclusive of improvements, and all land is assessed at the same rate per acre.

The real security for irrigation bonds is seen to be the lands to be irrigated, except that in some states town lots are included. The lien on these lands is not in the form of bonds or of notes of settlers, but of taxes levied by the districts, the laws of most states giving county treasurers authority to levy assessments if the district officials fail or neglect to do so. These tax liens are to be enforced in the same manner as other taxes.

The value of security depends, therefore, on the value of the land at forced sale, and that depends very largely on the demand for land, since most land in the arid region is fertile; and on the water supply, since desert land without a water supply is worth little or nothing. Therefore, it is not sufficient that districts be legally organized and that they have the good will of the owners of the lands included. In order that the bonds issued may be safe investments, it is necessary that there be a sufficient water supply and an effective demand for the land to be watered. The unimproved land itself is not worth the cost of the works to bring water to it. If the funds from the sale of bonds are wasted and the works are not completed, if the water supply is insufficient, if the lands are unsettled and there is no demand for them, or if, for any reason, settlers either do not come or cannot successfully grow crops, the lands are not worth the face of the bonds. For this reason the irrigation district law is not adapted to the reclamation of new lands, and it has not been a success for such lands. Its principal field of usefulness has been in the purchase of works already built and in use by the farmers already on the ground, and in providing additional works or water supply for such farmers. In such cases the farmers are there, and the lands are partly improved and are worth the amount of the bond issues, which serve only to add to their value.

The laws of all the states fix the minimum price at which bonds may be sold. They may be sold for less than par in California, if such sale is approved at a special election held for that purpose; they may not be sold below par in Idaho, Kansas, and Texas; for less than 95 in Colorado, Nebraska, New Mexico, and Utah; for less than 90 in Montana, Nevada, Oregon, Washington and Wyoming; or for less than 85 in Arizona. These provisions are made of no effect, however, by the provision, common to all laws, that the bonds may be used in payment for works already built or for materials and labor. A party taking the bonds in payment for works is not bound by the limitation on price, and fixes the price of the works according to the price which he can get for the bonds. Many bonds have in this way been disposed of for much less than the legal minimum price, the land owners paying much more than the cash price for the works.

The laws contemplate the initiation of districts by the land owners, but the usual practice, where the attempt is made to utilize this law for the irrigation of new lands, is for the promoters to work out a scheme and propose to the land owners to carry it out for a certain price in bonds. Instead of the district working out the plans, making estimates of the cost, voting bonds, selling bonds to the highest bidder, and purchasing works, the whole scheme is worked out for them, and they really vote on the acceptance of an offer from some promoter. The bonds are placed in the hands of a trustee to be paid out to the contractor as the works are being built, on estimates approved by the engineer of the district, and the contractor sells the bonds as best he can.

In some instances the contractors are interested in the lands to be reclaimed. In one instance, at least, the contractor was the owner of all the land, and as land owner he contracted with himself as a construction company to build works to furnish water to his own land and take his own bonds in payment. The bonds were to be deposited with a trustee who was to issue them to the construction company as the work progressed, on estimates made by the engineer of the construction company approved by the engineer of the district, both engineers representing the same party. Having secured the bonds, the contractor could sell them and thus obtain the money. The land was to be sold to farmers who would take it subject to the lien created by the district bonds. This scheme did not work out, however, but it calls attention to the necessity for investigating the ownership of the lands in a district, particularly as to the number of owners and their identity, before investing in the bonds.

For a number of years it has been almost impossible to sell irrigation district bonds, because of defaults in payments on bonds already issued. There has been a great deal of discussion of possible modifications of the district laws which will give such bonds a better financial standing, and some attempts in that direction have been made by giving the states some degree of supervision over the operations of districts.

In 1911 California created an irrigation bond commission composed of the attorney-general, the state engineer, and the state superintendent of banks. Bonds approved by this commission and certified by the state comptroller are made legal investments for all trust funds, funds of insurance companies, banks—both commercial and savings, and trust companies—state school funds and other public funds which may legally be invested in bonds of cities, counties, school districts, or municipalities, and for deposit as security for the performance of any act.

The submission of bonds to this commission is optional with districts. When a district applies to have a proposed bond issue certified, the commission is to investigate (1) the sufficiency of the water supply available and the right of the district to this water; (2) the nature of the soil as to its fertility and susceptibility to irrigation, and the probable need of drainage; (3) the feasibility of the irrigation system; (4) the reasonable market value of the water, water rights, and irrigation works owned or to be acquired by the district; (5) the reasonable market value of the lands of the district; and (6) whether the aggregate amount of bonds issued and to be issued by the district exceeds sixty per cent. of the reasonable aggregate value of the lands, rights, and works above mentioned. If the report of the commission is favorable on all these points, the comptroller is to certify the bonds, which then become available for the purposes mentioned.

California has provided, also, that plans for works for which bonds are to be issued shall be submitted to the state engineer, and that progress reports on the work must be submitted to the engineer. The law does not, however, give the engineer authority to see that the work is carried out according to the plans which he has approved, or to stop unsatisfactory work.

The Arizona district law, enacted in 1912, makes irrigation district bonds legal investments for the classes of funds named in the California law.

Several states have provided for more or less public supervision of irrigation districts. In California the petition for organization must be referred to the state engineer, who may report within thirty days but is not required to. If his report is adverse the district may still be organized on petition of three-fourths of the property owners. Idaho has a similar law. In New Mexico the state engineer is to investigate particularly the water supply and certify to this if he finds it satisfactory, but district directors may appeal from his decision to the courts if he reports adversely. In Oregon the state engineer reports what he deems proper, and the board then does what it deems proper. In California, after the district is organized and plans are made, these are submitted to the state engineer, who is to report on the sufficiency of the water supply and the feasibility of the project, but the board may do as it pleases as to proceeding with a bond election. Idaho and Oregon have somewhat similar laws. It will be seen that in no case is the adverse decision of the engineer final. It is probably true, however, that such a decision would kill a proposed organization or bond issue, as it is hard to sell district bonds under any circumstances, and would be impossible with an adverse report from a state official as an added handicap.

It is impossible to determine how much these laws have accomplished, but it is claimed that the California law has helped the sale of district bonds to some extent. It is felt by many in California that before district bonds can be considered first-class investments, and before the state should go far in lending its credit to such bonds, the state must have supervision over the expenditure of the funds raised by bond sales, as well as of the plans and the bonds. There is still the chance that the funds may be spent wastefully or unwisely, so that the security will be insufficient.

The Carey Act, approved August 18, 1894, attacked the problem from another angle. The author of this law had had experience with speculative holders of lands under a canal, who would not buy water rights, but sought to turn the investments of others to their own use. It appeared that if no one but purchasers of water rights could get the lands under a canal, the problem would be solved. This is the fundamental idea of the Carey Act. The Federal Government granted to each of the arid states 1,000,000 acres of public lands on condition that it be brought under irrigation and disposed of to actual settlers only. The law, of course, applies only to public lands. The scheme adopted for carrying out this law is for the state to contract with a construction company for the building of works to water a certain area of land, the company agreeing to sell water rights carrying an interest in the works to settlers on the lands at prices fixed in the contract, while the state agrees to sell the land only to parties who have contracted with the construction company for the purchase of water rights.

The original law did not, however, make the cost of works a lien on the land. The construction company was like the old companies which had failed, except that its water rights carried an interest in the works. Funds might be obtained in any way, but usually were obtained by the sale of either stocks or bonds, and the company made its profits by selling water rights for more than the cost of construction. Deferred payments could not be made a lien on the land, and consequently the only security such a company could offer to bond buyers was a lien on the works to be built and on the notes of settlers covering deferred payments on water rights. As with the earlier companies, the success of the whole scheme depended on the rapid and successful settlement of the land. Because of these weaknesses the Carey Act was almost a dead letter until 1896, when it was amended (Act of June 11, 1896) by providing that the states might create liens on the lands to be reclaimed. The text of this amendment is as follows:

> That under any law heretofore or hereafter enacted by any State, providing for the reclamation of arid

lands, in pursuance and acceptance of the terms of the grant made in section four of an act entitled "An act making appropriations for the sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five," approved August eighteenth, eighteen hundred and ninety-four, a lien or liens is hereby authorized to be created by the State to which such lands are granted and by no other authority whatever, and when created shall be valid on and against the separate legal subdivisions of land reclaimed, for the actual cost and necessary expenses of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers; and when an ample supply of water is actually furnished in a substantial ditch or canal, or by artesian wells or reservoirs, to reclaim a particular tract or tracts of such lands, then patents shall issue for the same to such State without regard to settlement or cultivation: Provided, That in no event, in no contingency, and under no circumstances shall the United States be in any manner directly or indirectly liable for any amount of such lien or liability, in whole or in part.

Since the United States cannot be made liable in any way for such a lien, the lands cannot be made security for bonds until title passes to the state, and under this amendment title does not pass until "an ample supply of water is actually furnished''; the lands to be reclaimed are not, therefore, security for bonds during the period of construction. While the states are authorized to create liens on the lands, it is not customary for them to do so directly, but to provide in contracts with construction companies that the notes of settlers given to secure deferred payments on water rights shall be first liens on their lands. Usually these notes are deposited with a trustee as security for bonds, and the deferred payments, when made, create a fund from which the bonds are paid. Under this scheme the promoters provide sufficient capital to partially complete the works; they then sell water rights, and issue bonds secured by their rights, the works built, and the notes of settlers securing deferred payments. Under the water-right contracts the works become the property of water users, subject to this lien. After having sold the bonds, completed the works, and turned them over to the water users, organized into a mutual company, the construction company is through with a project. Some of the deeds of trust used provide that bonds may not be certified until notes securing deferred payments are deposited with the trustee, the deeds requiring that notes to twenty-five or fifty per cent. in excess of the face value of the bonds must be on deposit with the trustee. It will be seen that under this scheme the financial success of a project depends on the rapid and successful settlement of lands to be reclaimed, just as it did under the older schemes which failed.

New Mexico and Arizona, which have enacted the latest laws accepting the conditions of the Carey Act, have provided in an indefinite way for the creation of liens directly by the state. The New Mexico law provides that when a contract is made with a construction company for supplying water for reclaiming land "in order that patents may issue therefor to the Territory without regard to settlement or cultivation, as provided by act of Congress of June 11, 1896, said Carey Act Board may make such contract . . . creating the lien upon such lands for the cost of reclamation and interest thereon . . . as the board may deem proper, not inconsistent with the acts of Congress relating thereto." This provision is peculiar to New Mexico, and no contracts under it have yet been entered into. The Arizona law provides for the creation of a lien in favor of the contractor, with interest at six per cent., but no occasion for the enforcement of this law has yet arisen.

As with irrigation districts, the sufficiency of the security behind Carey Act bonds depends upon the successful settlement and cultivation of the lands covered by the projects. The desert lands in their natural condition are not worth the face of the bonds, and if the works are not successfully completed, or if the purchasers of lands, after making one payment and giving their notes for the balance of the purchase price of rights, decide to drop their investments, the bond holders have only the rights of the construction company, the works built, and the notes of settlers. These notes are a lien only on the settlers' interests in these lands, and since they cannot get title until a water supply is provided, their interests in their lands prior to getting title are worth very little.

Because of the fact that the Carey Act enterprises are carried out under contracts with the states, and that these contracts must be approved by the U. S. Department of the Interior, there is a more or less common impression that these enterprises are guaranteed in some way by either the state or the Federal Government. This impression is entirely false. The Federal approval applies to the plans. There is no supervision or inspection by the Federal Government to insure the fulfilment of the plans. The states usually exercise some supervision over the operations of the companies and compel them to complete their works, and their contracts provide for forfeiture of rights and works partially completed if the works are not finished, and for the letting of new contracts to complete them, but they do not themselves guarantee to either the land buyers or the bond buyers that the enterprise will be carried out or the bonds paid.

Irrigation bonds find their way largely into the hands of small investors, and bond salesmen make much of the agricultural success of irrigation. While this success adds to the security of the bonds, it should be kept in mind that a bond holder does not participate in any way in the profits of either the construction company or the farmer. He gets at the most only the interest on his bond and the face of the bond at maturity.

Bonds of Carey Act companies, like those of irrigation districts, are difficult to sell at the present time, and a great deal of discussion of these bonds as investments has taken place. One of the most interesting discussions published is the report of the committee on "irrigation, reclamation and agricultural credits" of the Investment Bankers Association of America, contained in the proceedings of the convention of that association held in Philadelphia, November 12 and 13, 1914. The report of this committee is in part as follows:

> Within the past few years many million dollars of irrigation bonds have been sold to investors throughout the United States, and, while a large amount of

these securities are good and will be paid, both as to principal and interest, yet it is unquestionably true that there are many millions of dollars of these bonds in default, and, in most cases, there is no relief in sight for the holders, many thousands of whom can ill afford to lose either the principal or the interest of their investments. Owing to the breaking down of the irrigation bond market, many uncompleted meritorious irrigation projects are now at a standstill, caused by lack of capital with which to carry the work to completion. The holders of bonds of these projects are under the necessity of either furnishing additional funds with which to complete the work or being satisfied to hold securities of uncertain value, upon which no interest is paid. In the absence of a market for irrigation securities, many new projects in the western states cannot be undertaken, because no funds for development purposes can be secured. The conditions in this respect are so bad that even old and successful irrigation enterprises now find it extremely difficult to secure new capital with which to purchase additional water rights, or to enlarge and repair their reservoirs and canal systems. This chaotic condition is not only working a great hardship upon the holders of good irrigation bonds, who are entitled to have some kind of a market in case they should desire to sell, but also upon scores of irrigation enterprises having great merit, many of which are necessary to the proper development of the arid regions in several of our Western states. Because of these conditions, we have thought it wise to direct most of the efforts of our committee during the past year to a study of the irrigation situation, rather than to the subject of reclamation and agricultural credits, having in mind that if we could ascertain the reasons for the failures in the past, we could, through this knowledge, perhaps undertake something of a constructive nature in the future, or at least be in a position to cooperate in the effort which is being earnestly made by many persons to rectify, if possible, the mistakes of the past and restore the confidence of investors in irrigation bonds.

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A careful study of the situation has shown that the mistakes of the past have been due to many causes, among which may be mentioned:

1. Dishonesty or incompetency on the part of the promoters.
2. The fact that only from fifty to sixty per cent. of the proceeds of bonds sold actually went into construction work, the balance being absorbed by underwriters, and by construction contractors made up of persons interested in the promotion of the undertaking; interest being payable, however, upon the total par value of the bond issue.
3. Lack of capital to complete work.
4. Insufficient water.
5. Bad management.
6. Poor construction work.

7. Absence of settlers.

8. Ignorance of the settlers as to the use and application of irrigation water, or lack of capital with which to make improvements, or purchase farming implements.

9. Insufficient transportation facilities for marketing farm products.

10. Newness of the country, rendering farming unprofitable during the first few years, and inability of the settler for this reason to meet principal payments for the purchase of his land in accordance with contract.

Any one of these defects might well be considered almost fatal to a successful outcome, yet our investigations have shown that, when failure has occurred, a majority of the above enumerated causes have been found to exist. Under these circumstances it is no wonder that there is such a universal distrust of irrigation securities, and it will require heroic efforts to bring about a restoration of confidence, but we believe that many forces are now effectively at work with this end in view, and that satisfactory results will surely follow. Already some of the districts whose obligations are in default are slowly being reorganized and placed upon proper footing, but this is generally being done by the holders of the obligations, rather than through other agencies.

Holders of defaulted irrigation bonds upon uncompleted projects should get together and put up a sufficient amount of money to employ an irrigation engineer of high standing and a good practical irrigation expert to investigate and report upon:

1. Whether the project is fundamentally sound from an engineering standpoint.

2. The maximum cost of completing the work, and the debt per acre of irrigable land after all work is completed.

3. All of the conditions relating to water supply, location, access to market, and all other necessary facts and figures.

If all of these things are satisfactory and it is then found that there is sufficient land susceptible of irrigation to make the enterprise profitable, then the bond holders should seriously consider the advisability of putting up the necessary amount of money to complete the work, but before doing so, they should secure, as far as possible, the coöperation of the promoters and the owners of the land under the water system, so that the best results may be obtained.

It also should be borne in mind that settlers under new projects should be treated as pioneers and given all necessary time in which to develop and improve their lands and adapt themselves to the adverse conditions of a new country before the first of the principal payments become due, otherwise defaults are almost sure to occur, no matter how meritorious the enterprise may be.

Many clear-thinking investment bankers, experienced in irrigation securities, are strongly advocating that the irrigation states, or counties therein, should lend their credit to municipal irrigation and drainage districts by passing laws, making bonds, issued for construction and improvement purposes, a general obligation of the state or county, to be paid through direct ad valorem taxes, with the provision, however, that said cost of construction or improvements is to be repaid to the state or county by the owners of the property directly benefited. Such laws would necessarily have to be very carefully safeguarded, and the feasibility and cost of the contemplated project determined and carefully considered in advance of the expenditure of any money. Otherwise the outcome might work a loss and a great hardship upon the taxpayers not owning property in the district benefited, in cases where the undertaking failed of success.

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Before leaving the subject of irrigation securities, we wish to impress upon our members that there are now outstanding, and undoubtedly will be issued in the future, two distinct types of irrigation bonds, as follows:

1. Bonds issued and sold for construction purposes, in connection with which the purchaser, in order to secure a high interest yield, takes all the chances which go with any proposition which has not been proven to be safe and profitable from actual experience. Substantially all irrigation securities that are now in default are bonds of this type.

2. Bonds issued upon completed, established, and successful projects, for the purpose of refunding previous issues, or to provide funds with which to purchase additional water rights, or to repair or enlarge canals and reservoirs.

Dealers and investors should use great care to distinguish between these two classes of bonds, for the reason that one may possibly contain all the elements of speculation, whereas the other may possess all the elements of strength and safety.

The report quoted relates almost entirely to irrigation district bonds, but much of it applies equally well to Carey Act bonds. The distinction, made in the last paragraphs, between bonds for the construction of new projects and those for the purchase, extension, or improvement of existing projects is especially valuable. This emphasizes the point made by the author, that the irrigation district scheme, as it stands, is not adapted to the construction of new projects, for the reason that the security for the bonds is not sufficient. District bonds issued for such purposes, and practically all Carey Act bonds, are like all industrial bonds in that their value depends upon the success of the enterprises on which they are based rather than upon the value of the property upon which they are a nominal lien. If the attempted sale of these bonds were confined to capitalists and investors who recognize the facts just stated, and who are in the habit of buying industrial bonds, little harm would be done. Such persons recognize that they are taking chances and do so with their eyes open. The harm has come from the sale of such bonds to small investors on the false representation that they are, in the case of districts, municipal bonds backed in some way by the states and counties, and, in the case of Carey Act bonds, that they are liens on the lands and are backed by the states and the Federal Government.

Where districts are organized to buy irrigation systems already supplying water to lands which are settled and in cultivation, and to enlarge or improve such systems, the bonds are not subject to the criticism just made.

If companies operating under the Carey Act provided the capital necessary to build works and carry their projects until the lands were settled and largely improved, they would then be in position to issue bonds which would not be speculative in character. In fact, that seems to be the real solution of the Carey Act problem. Let the promoters who wish to undertake such projects organize construction companies and sell stock or bonds, which are admitted to be more or less speculative, to parties who knowingly undertake such enterprises, and later refund these by selling bonds which are in fact secured by the lands of the projects. Such a course would have a tendency to restrict construction to some extent and reduce the probability of the undertaking of projects to reclaim lands for which there is no real demand. It has been too easy to start projects, sell bonds, and get out. Most of the states have the machinery and the laws necessary for putting such a system into effect, as their laws place upon the boards handling such matters the responsibility of determining the financial ability of the applicants for contracts for reclaiming lands under the Carey Act.

IRRIGATED LANDS

Improved lands under irrigation can be purchased as can improved lands anywhere. The land offered for sale by colonization and land agents is not usually in this class, however, but is land under new enterprises which are under development. Such land is extensively advertised either by the promoters of the enterprises themselves or by companies or individuals who make a specialty of selling lands of this class, the appeal being made especially to persons who wish to make homes on the land, rather than to those who buy for speculation. For this reason the subject of investments in irrigated land is discussed here strictly from the standpoint of the prospective settler.

There are at present four general classes of agencies engaged in developing new land which is open to settlement: the United States Reclamation Service, Carey Act enterprises, irrigation district enterprises, and commercial enterprises.

The enterprises of the United States Reclamation Service supply water to two classes of lands—public and private. Public lands under such projects can be obtained only under the Homestead Law, under which the settler gets the land free of purchase price, other than land-office fees ranging from $6 to $16 for an entire entry. The law requires, however, three years' actual residence on the land, and the reclamation of at least one-half of the irrigable area within the entry, and the payment of the water charges apportioned against the land by the Reclamation Service. The commutation clause of the Homestead Law, under which title can be obtained at the end of fourteen months by the payment of $1.25 per acre, does not apply to lands under reclamation projects.

Under the Homestead Law a settler may take up 160 acres, but the Reclamation Law authorizes the Secretary of the Interior to limit the area per entry under the reclamation projects to the "acreage which, in the opinion of the Secretary, may be reasonably required for the support of a family upon the lands in question." The extent of the area which may be taken under any project is published when notice of the opening of the project is given, and the "farm units" range from 10 to 160 acres. Prior to such notice a settler may enter 160 acres under agreement to relinquish all in excess of the limit fixed by the Secretary when such a limit is fixed.

The entryman must establish his residence on the land within six months from the date of his entry, without regard to whether the water for irrigation of his land is available, and maintain it continuously. The prospective settler on lands under reclamation projects should keep this in mind, for, until notice of the opening of a project is published, the Government is not bound in any way to furnish water at any particular time, and the settler has no recourse if the opening is so long delayed that he cannot maintain his residence. In seeking the advantage of entry in advance of the opening of the project he assumes the risk of delay in that opening, as well as the risk of having his entry cut down to less than 160 acres.

It is the intent of the law that the cost of water rights be fixed so that the returns from all the land included in the project will cover the estimated cost of the works. While there are probably assumed to be preliminary estimates of approximate cost, these were not accepted by the Secretary of the Interior, and not until notice of the opening of a project is published is the price finally fixed. The person filing in advance of notice assumes, therefore, the risk of having to pay for the water rights a much higher price than he may have expected at the time of filing. In fact, this has been the usual experience up to the present time. Since the price of rights depends on the cost of the works per acre to be served, it shows no uniformity, the average being about $55 per acre.

Under the original law water rights were to be paid for in not more than ten annual installments, without interest on the deferred payments. An amendment made in 1914 extended the time to twenty years, with only operation and maintenance charges to be paid the first four years in many instances. There is no uniformity in the time of making the first payment, this time being fixed for each project by the Secretary of the Interior according to local conditions. The first payment may not be required for several years after water is furnished. In fact, several of the reclamation projects are being operated under temporary rental agreements for an indefinite time, neither the amount of the water-right charge nor the time when it will become due being known to the water user.

The settler does not get title to his land until he has lived on it at least three years, reclaimed one-half of the irrigable area, and paid the entire water-right charge. For that reason he cannot mortgage the land for at least three years, and, if the water-right charges are paid only as required by law, it would appear that the land cannot be mortgaged within twenty years from the date of the first payment, although in some sections the banks are making arrangements for loans on these lands. The land can be assigned after three years of residence have been completed, if all charges due at that time have been paid.

Entries can be relinquished to the Government at any time, and the original entryman can sell his improvements and his interest in the water rights attached to the land to the new entryman. The new entryman does not get credit for the time during which the original entryman resided on the land, but must himself reside on it for the full period of three years. He does, however, get credit for the payments of water-right charges made by the original entryman, by filing with his entry an assignment of the interest of the prior entryman. While he gets the credit for payments made by his predecessor, he takes the land subject to any charges which have been levied against it and remain unpaid.

Water rights are subject to cancellation in case of failure to make any two payments when due, and, if this default occurs after any payments have been made, the entryman forfeits to the United States all previous payments.

While the Reclamation Law apparently applies primarily to public lands, it provides for supplying water to lands in private ownership, and in some of the projects there are large areas of such lands. The law provides that no person can obtain water for more than 160 acres, and, since many persons own larger tracts, their holdings above 160 acres are usually for sale. In fact, persons who own land in excess of 160 acres are required to enter into agreements to sell their surplus holdings before they are allowed to purchase water rights for any part of their lands.

These lands are purchased from their owners just as any other lands are purchased, the prices being a matter of agreement between the parties. The lands are subject to the same water-right charges as lands taken under the Homestead Law, but the payment of these charges must be secured in a different manner, since the title to the land is not in the Government. The lands are virtually mortgaged to secure these payments, but the mortgage is not held directly by the United States. All owners of private lands receiving water from a reclamation project are organized into a water users' association, and are required to authorize this association to sell their lands to satisfy this lien if payments are not made when due. The water users' association obligates itself to the Government to see that water-right charges are paid, and secures itself by the agreements of its members to allow it to sell the lands if payments are not made. The by-laws of the association fix the manner of selling the lands to satisfy delinquent water-right payments.

The purchaser of private lands under a reclamation project, therefore, must pay for the land whatever price is agreed upon, and assume also the obligation of paying the cost of the water right at the same rate as the settlers on public lands.

The purchaser of private land is not required to live on his land but may be an "occupant of the land residing in the neighborhood of said land," when application is made and when final proof is made. Under present rulings the limit of "the neighborhood" is fixed at fifty miles. The owner of private lands may at any time make all the payments on the purchase of his water rights, and be relieved of the lien on his lands.

In addition to being liable for the purchase of water rights, the lands are subject also to annual charges to cover the cost of maintenance and operation. This has usually been made a flat rate per acre, based on the estimated annual cost, but the law extending the time of payment to twenty years requires that annual charges be based on the quantity of water delivered. Maintenance and operation charges are not made a lien on the lands, but under regulations of the water users' associations water is not delivered to any person who is in arrears in the payment of water-right charges.

Until the water-right charges are paid, the management of the irrigation works is in the hands of the Reclamation Service, but under the law "when the payments required by this Act are made for the major portion of the land irrigated from the waters of any works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby to be maintained at their expense." The ownership of the works remains, however, in the Government until Congress provides otherwise. This law plainly intimates that the works are to become the property of the land owners eventually, but without further legislation the land owners will not have title to the works, although they may have repaid to the Government the entire cost of the works. In this the reclamation projects differ from Carey Act or irrigation district enterprises, since in enterprises of these other kinds the water users, after paying the cost of the works which serve their lands, actually own these works. The time has not yet come for turning any of the reclamation projects over to the water users, and it is not possible to anticipate the effect of the retention of the ownership by the Government. This does not seem to be a matter of great consequence, however, since the right to use the water furnished by these works is attached to the land perpetually and the land owners are to be given control.

While the building of irrigation works and the sale of water rights by the Government give every reason for the settler under these projects to have confidence in the sufficiency of the water supply and the stability of the works, neither is guaranteed. The rights of the Government to water from streams, etc., are subject to state laws regarding priority, etc., just as are other rights, and government enterprises are subject to the same risks of drought and flood as other enterprises. It can be said in favor of these enterprises that the water rights and the water supply are, as a general rule, more carefully investigated than is the case with other projects, and the works are likely to be of more substantial construction, but the belief held by some that the Government guarantees any of the items is unfounded.

The water-right charges cover the cost of the main canals and the laterals, leaving the sublaterals in many cases and the farm ditches to be built by the water users either singly or in groups.

The limit of the quantity of water to be delivered to each acre of land varies with the different projects, but never exceeds the quantity necessary for the proper irrigation of the land. In other words, the purchaser of a water right is not entitled to a certain quantity of water, but to water enough for a certain area of land. Under government projects, as under others, the water-right purchaser is not guaranteed sufficient water for his land, but in case of shortage is to receive only his share of whatever quantity is available.

Since the law provides that no one person may secure water for more than 160 acres from a reclamation project, this acreage is the limit of the land holdings of any individual, until after his rights are paid for, and the limit may be placed lower by the Secretary of the Interior. There is, therefore, no opportunity for expansion under such a project, and the water user must be satisfied with a single farm unit, or go elsewhere unless he pays up fully all deferred installments on each farm unit purchased.

Under the *Carey Act*, the lands to be reclaimed belong, when an enterprise is begun, to the Federal Government. The lands are segregated by the Government and withdrawn from entry under any of the land laws of the United States, pending their reclamation. When a water supply has been provided, they are patented by the Government to the state, and settlers obtain them from the state. The state enters into contract with a construction company under which the company agrees to build works to supply the land with water, to sell rights to water to purchasers of the land from the state at prices fixed in the contract, to maintain and operate the works until a certain proportion of the total rights, fixed in the contract, has been sold. These rights entitle the purchaser to an interest in the works as well as a water supply, so that when all rights are sold the works become the property of the water-right holders. The state, on its part, agrees to sell lands only to parties who have contracted with the construction company for the purchase of water rights. The person wishing to obtain lands being reclaimed under the Carey Act, must, therefore, deal with two parties, buying water rights from a construction company and land from the state.

The prices of land to be reclaimed under the Carey Act are fixed in the laws of the various states, but fifty cents per acre is the most common price. One-half of this must be paid at the time of making application for the purchase of the land, and the other half when final proof of residence and improvement is made.

The Carey Act itself provides that the land shall be disposed of to actual settlers only, but under the regulations only thirty days actual residence is required, making this provision of the law a farce. To obtain title to land under this law, the settler must enter into contract with the construction company for a water right, maintain a nominal residence of thirty days on the land, and cultivate one-eighth of the land entered and pay the price of the land.

Land may be entered as soon as it is segregated and construction work has begun, but settlement need not be made until notice is published by the construction company that water for irrigation is available.

Water rights are usually paid for in installments, and interest is charged on deferred payments. These deferred payments are secured by notes which are made liens on the settlers' interest in the land, with provision for giving mortgages as soon as title is obtained.

The fact that plans for the Carey Act enterprises must be approved by the U. S. Department of the Interior and by the state in which they are located has led to a popular belief that the projects are in some way guaranteed by the Federal Government, as in the case of the reclamation enterprises, or by the state or by both, but this is a mistake. This approval adds to the probability of the plans being sound, and of the proper construction of the works, but it does not assure either of these. The fact that the construction company is under contract with the state to build the works and turn them over to the water users, gives assurance that this will be accomplished, but it does not guarantee it. Most of the state laws provide that, if a construction company fails, the state shall take over the incomplete works, and advertise for someone else to complete them. But there is no provision for the completion of such works by the state in case no satisfactory bids are received.

It follows, therefore, that the purchaser of Carey Act lands must buy them and his water right on the general evidences of the sufficiency of the water supply and the stability of the construction company rather than on any guarantee by the Federal Government or the state.

The limit of area which can be purchased from the state under the Carey Act is 160 acres, but this does not limit a future acquisition of land from individuals after they have received patent from the state.

Patent can be secured after the establishment of residence, the purchase of a water right for the irrigable area of the holding, the reclamation of at least one-eighth of the land, and the payment of the purchase price of the land. It is not required that the water rights shall be entirely paid for before patent is secured, as under the Reclamation Law.

Deferred payments on water rights and delinquent maintenance and operation charges are liens on the land after title has passed to the purchaser, and these liens are to be enforced by the sale of the land under the usual foreclosure procedure.

The purchaser of a water right is nominally entitled to a certain quantity of water, but is actually entitled to his pro rata share of whatever water is available.

When a certain proportion of the rights have been sold the works become the property of the water-right purchasers and are turned over to them to be maintained and operated by them. Water rights are exchanged for stock in a mutual company to which title to the works and rights passes. Stock is issued in proportion to the land purchased, and whatever water is made available by the works is divided among the stockholders in proportion to the stock held.

After the works have been turned over to the stock company, the costs of operation and maintenance are met by assessments on the stock, the amount of these assessments being governed, of course, by the amount of the costs.

Irrigation districts are public corporations organized, in most states, under the supervision of the county commissioners of the counties in which the districts are located. These districts are given authority to issue bonds to obtain money for the construction or purchase of works and to levy and collect taxes for the payment of the bonds and other expenses. Since Government and state lands are exempt from taxation, they cannot ordinarily be included in districts. Irrigation districts are, therefore, composed entirely of private lands, although most of the state laws provide for entrymen on public lands and holders of leases of state lands getting water from districts on rental agreement until title to their land is obtained, after which the lands become subject to district taxes.

Lands in irrigation districts, therefore, must be purchased from their owners at prices and on terms agreed upon between the parties. There is no purchase of water rights because the fact that the land is in the district entitles its owner to his proportional share of whatever water is available.

The land is subject to the lien created by the issue of bonds, and the purchaser of such lands should determine how much this lien is and whether any of it has been paid off. Under most district laws, only the interest on the bonds issued is paid during the first ten years after the bonds are issued. Payments on the principal begin in the eleventh year, the laws specifying what percentage of the bonds shall be paid each year.

Some of the states have laws providing for more or less supervision of irrigation districts, some inspection and approval of plans, and some supervision of construction, but the fact that districts are public corporations, are given the taxing power, and operate under some degree of public supervision, does not give any guarantee of the sufficiency of the water supply or the stability of the rights. As with reclamation and Carey Act enterprises, the purchaser of the lands in a district must depend on the general evidences of stability and reliability rather than any guarantee because of the public nature of the district.

State laws differ as to the manner of assessing lands for district purposes. In some all lands are assessed for district purposes at the same rate per acre, so that every acre in a district will pay the same amount both of the bonds and of operation and maintenance charges. Other laws provide that district taxes shall be levied on the assessment for state and county taxes exclusive of improvements, while still other laws provide for levying assessments according to the benefits received from the works of the district. Under all these laws the taxes levied are liens on the lands, to be enforced in the same manner as delinquent state and county taxes.

Districts are managed by boards of directors elected annually by the owners of the lands within the districts. These directors estimate the amount of money necessary to be raised, and levy taxes accordingly. As a protection to bond holders, the laws provide for the levy of district taxes by county officials if the district directors fail to levy them.

In addition to the public and semi-public agencies engaged in developing irrigated lands, which have just been described, there are *private enterprises* which are building irrigation works and offering lands for sale. Most of these follow the general plan of the Carey Act, already described, so far as disposing of lands and water rights is concerned. Their usual plan of operation is to obtain title to the land to be irrigated, build the works to supply the water for irrigation, and sell the land with water rights which carry an interest in the works, so that when all the rights are sold the works will become the property of the land owners. Many of these schemes include also provisions for preparing the land for irrigation, and planting and caring for it for a term of years, so that the purchaser may continue his present occupation while paying for his land and water rights, and while his land is being put into shape to support him.

The rights of such private enterprises to water from streams are subject to the same laws as those of the public enterprises already described. So far as the fact that the enterprises are private rather than public is concerned, their rights are just as likely as the others to be good. A full discussion of water rights is found on pages 165 and following.

In recent years private enterprises of this character have been usually comparatively small, and offer for sale principally fruit lands in small tracts at high prices. The promoters agree to build the irrigation works, provide a water supply, clear and level the land, plant and care for the trees for five years, at the end of which time the payments will have been made and the works will be turned over to the water users. The cost of all this is included in the price of the land and water rights.

The prices range as high as $400 and $500 per acre, and lands and rights are sold on partial payments, with interest on deferred payments. Payments are to be made monthly, as a rule. In some cases the deferred payments are made liens on the lands and rights, to be enforced in the usual manner for deeds of trust, while in other cases the purchaser receives a contract for a deed which is to be delivered when the payments shall have been made.

This plan undoubtedly enables many persons to buy lands who could do so under no other plan, since they can continue to earn money at some other occupation while their lands are being prepared for them. Initial payments are small, there are no residence requirements, there are no restrictions as to the acreage which may be taken, and the land is brought into condition where it will provide a living for the settler before he abandons his other means of support.

The greatest weakness of the scheme is that it depends almost entirely upon the good faith and ability of the promoters. The small investor is in no position to assure himself as to the water rights, the water supply, the character of the land, or the advantages of the section as a fruit-growing region. Nor is he in position to see that his land is actually being planted and cultivated and brought into producing condition, as provided in his contract. For all of these things he must depend upon the reliability and good faith of the promoters. He acquires, of course, an equity in the land, which can be enforced, but the land without the improvements provided for in the contracts is not, as a rule, worth any more than the first payment made by the purchaser. If the improvements are not made, the security is not good for the payments made.

Enterprises of the types described above all deal with new lands. There are, of course, improved farms for sale by individuals under all kinds of enterprises. However, probably ninety per cent. of the improved lands under old established irrigation systems are supplied with water by individual, partnership, or coöperative enterprises.

Speaking generally, the ditches watering single farms or a few adjoining farms, and controlled by individuals or partnerships, are in more or less isolated locations where lands are of comparatively low value, and crops consist chiefly of hay and grain. As a rule, the water is obtained from small streams where the supply of each is independent of all others and complications regarding water rights are not likely to be of great importance. The principal question regarding such rights relates to the supply of water rather than to rights to its use. These streams usually have a flood flow in spring or early summer, when hay and early grain crops need water, and are very low or entirely dry in the late summer, when higher-priced crops, such as sugar beets, potatoes, and fruits need it. The returns of the last census show that forty-five and a half per cent. of all the land irrigated in 1909 was supplied with water by enterprises of this class.

By far the larger part of the irrigated land in the highly developed sections such as the fruit lands of southern California, and the potato and beet lands of Colorado, Idaho, and Utah, is supplied with water by systems controlled by the water users under some form of coöperative organization. The most common form of organization for this purpose is the stock company, with the stock owned by the water users. In most states stock in such a company can be owned separately from the land, and the purchaser of such lands should obtain with his land the ditch stock necessary to provide his water supply. The ownership of this stock will entitle him to his share of the water belonging to the enterprise, and to a share in the control of the affairs of the enterprise. The price of this stock is a matter of agreement between the parties to the bargain. Usually the face value of stock bears no relation to its selling value, which is governed rather by the stability and abundance of the water supply of the particular enterprise in question. In fact, the current prices of stock in any such enterprises are the best possible index to the reliability of the water supply.

WATER RIGHTS

The principal source of water supply for irrigation in the United States is the surface stream, the reports of the last census showing that ninety-four per cent. of the land irrigated in 1909 was supplied from that source. The fundamental principles of rights to water from streams and other sources are discussed in another chapter. In this chapter the practical phases of the subject, which are of interest to the purchaser of lands in the arid region, are discussed.

The purchaser of irrigated lands is interested first in the character of the right which the party from whom he is buying proposes to give him, and unless he has been advised on the subject is apt to think that is the most important thing. Back of that, however, he is interested in the character of the right possessed by the individual who is selling him the right. The stability of this fundamental right is, in fact, far more important than the other, for no matter what kind of a contract or agreement is offered to the purchaser, no such right can be any better than the fundamental right in which it transfers an interest. In other words, the purchaser of irrigated lands must inform himself as to two classes of rights, the right of the individual or company from whom he proposes to buy, to take water from the original source; and the contract or agreement under which he is to acquire an interest in that right.

Rights to Water from Original Sources.—Originally throughout the arid region rights to use water from streams were acquired by appropriation—that is, a right to take water from any source was established by taking it. Having taken water and put it to use, the appropriator had a right to continue to take and use water from the same source, and to protection in that use against those who later took water from the same source. These are what are known as the rights of appropriation and priority. This is the whole American system of water rights in its simplest terms. There is probably no more complex and confused subject than that of water rights in the arid states, but most of this confusion and complexity come from attempts to interpret and enforce these two apparently simple principles relating to water rights.

Since the supply of water is limited, it is evident that it is not possible to allow everyone who may want to take water from any source to "appropriate" it without restriction. The right to appropriate is limited by the right of the prior appropriator to continue to take and use water. Thus the value of any right depends more largely upon the volume of prior rights to water from the same source than upon the right itself. It is not sufficient, therefore, for the purchaser of a water right to investigate only the right of the party selling rights. He must investigate all rights to the same source. For instance, a party in Colorado may have a certificate from the court that he has a right to 200 cubic feet of water per second from a certain stream, dating from a certain year, and that this right is number twenty on the stream. If the flow of the stream during the crop-growing season is sufficient to supply water to all rights up to and including number twenty, then the right is good, but if the stream supplies throughout the season only water enough for rights up to number fifteen, and enough to include number twenty only in extreme floods, then right number twenty is of little value, notwithstanding it is represented by a certificate issued by the court as the result of an adjudication.

Rights to water direct from streams are represented by the following evidences of title: Filings in county records; filings in the state engineers' offices; certificates from courts, state engineers, or state boards; and permits from state engineers or boards. The force of these various evidences of title as guarantees of the value of rights is discussed in the following paragraphs.

As pointed out in Chapter VI, the filing of a notice of water-right claim merely gives notice of an intention to divert water, and its only effect is to fix the date of the right at the date of filing the notice, rather than at the date of beginning construction, if the notice is filed before construction begins. The filing, in itself gives no right, but it must be followed by the construction of the works described in the notice and by the use of the water claimed. This construction may or may not have followed the filing of the notice, so that in itself such a filing is worthless as evidence that the party making the filing has a right to the water claimed. The right may be perfectly good, but the filing alone does not prove this, and no one should purchase a right based on such a filing without additional evidence that the right is valid and that there is sufficient water in the source claimed to supply not only the right in question but all prior rights.

In Colorado a person wishing to divert water from a stream must file a map and plans with the state engineer, and if the map and plans are in proper form and set forth clearly what is claimed, they must be approved by the engineer, and a copy showing this approval is returned to the claimant. These filings, like those in county offices, are merely notices of intention to divert and use water, and the approval of the engineer conveys no right whatever. As pointed out, the engineer is required to approve such a filing if it sets out clearly what is claimed, even if he knows that there are already more rights to water from the source claimed than it can supply. Thus the approval of the engineer is no proof whatever that the right has any value, or that there is any unappropriated water to which rights can be acquired if the plans approved are carried out. As in the case of filings in the counties, the rights represented by plans approved by the state engineer in Colorado may be good, but the approved plans are no evidence of that fact.

When rights are adjudicated by the courts, certificates are issued to the holders of rights stating the volumes of water to which the holders of rights are entitled, the dates of these rights, and the numbers of the rights, in the order of their priority. These certificates are proof that the persons holding them had, at the time the adjudications were made, rights to the volumes of water set forth in the certificates. They do not, however, show that there is water in the streams to supply these rights. As previously explained, these rights are to be supplied in the order of their dates, and if the stream does not supply water enough for all rights, those of late date receive no water. A certificate showing that a court has confirmed a right to a certain amount of water from a stream is no evidence, therefore, that the holder can get the given amount of water. Whether the right is of value depends upon the volume of rights of earlier date and the flow of the stream. A further element of uncertainty is added by the fact that rights are lost by non-use, the period of non-use which brings about forfeiture of rights being fixed by law in most of the states. A right certified to by a court and good at the time may have been lost by abandonment, and the certificate be still in the hands of the former holder of the right.

In Wyoming and the other states which have adopted its system of control of streams, rights to water from primary sources are represented by certificates from the state, setting forth the date, extent, and location of the right. These certificates are conclusive evidence that the holder had a right to the volume of water named in them for use on the lands specified, but, like the certificates from the courts in Colorado, they do not carry any guarantee that there is or will be water in the source named to supply the right for any considerable part of the season. There may be enough prior rights to water from the same source to use all the water in ordinary stages of the supply. As in Colorado, rights may be lost by abandonment, without the surrender of the certificate evidencing these rights.

Permits from state engineers to appropriate water have different effects in the various states. An approved application constitutes a permit. In Wyoming and several other states the state engineer has authority to refuse to approve an application if there is no unappropriated water in the source of supply, or if the approval is contrary to the public interests. In Idaho, on the other hand, the engineer is required to approve any application which is in proper form. An approved application to appropriate water in one of the first group of states referred to would be some indication, although not a guarantee, that in the opinion of the engineer there was unappropriated water in the source named in the application. Some engineers take the position that the "appropriator" is presumed to have examined the water supply, and makes his investments at his own risk. There is considerable justification for this attitude in the fact that conditions so change that water will become available, although it may appear at the time of the application that there is none. The same argument applies to the laws of Colorado and Idaho requiring the approval of any filing or application made in proper form. If the water supply in any source were a fixed quantity from year to year, there would be no excuse for this practice, but since neither the engineer nor the intending appropriator can predict with any assurance how much water a given stream will supply in any season, it seems justifiable to approve applications to an extent in excess of the apparent supply if the intending appropriator wishes to take a chance on getting water. He is not entitled to water until all prior rights are satisfied and cannot injure these prior rights. Against this practice, however, there is one very serious objection—it opens the way for unscrupulous promoters to trade on the ignorance of investors in irrigation securities or lands. Enterprises based on permits to appropriate water which in all probability does not exist are launched, and stocks, bonds, or lands, or all three, are sold to small investors, who assume that a permit from a state official to take a certain volume of water from a certain source is a guarantee that there is water there to take. In this way the holder of the permit transfers the risk, which he fully understands, to parties who do not understand it.

To guard against this, the Wyoming engineer adopted the practice of stamping across the face of permits to appropriate water in excess of the normal supply a statement to that effect, and that it appears that water will be available only in flood periods. Idaho has provided by law for examination of projects by the state engineer and the issuing of permits to sell water rights, fixing the limit of the rights which may be sold, seeking in this way to counteract the evils arising from its law requiring the engineer to approve all applications to appropriate water made in proper form.

The investor in irrigation securities, irrigated lands, or water rights should understand, therefore, that a permit to appropriate water is not a guarantee on the part of the state issuing it that the quantity of water named in the permit is available.

Even if water be available, a permit, in itself, does not constitute a right to water. It conveys a right to acquire a right by building works, appropriating the water, and putting it to the use named in the permit. These later steps are just as necessary to the acquisition of the right as the obtaining of the permit. The permit itself fixes the time within which the works must be begun and completed and the time within which the water must be put to use, and a failure to fulfill any of these conditions is fatal to the acquisition of the right.

The states requiring applications for permits to appropriate water provide for issuing certificates that the works described in the permit have been built and the water put to use.

Wyoming, the first state to adopt this system, issues a single certificate after the submission of proof similar to that required in the adjudication of rights by the board of control. Nebraska and Oregon have adopted the same system. Idaho, New Mexico, North Dakota, Oklahoma, South Dakota, and Utah issue certificates of completion of works after submission of proof and examination by the engineer, and, after submission of proof that the water has been put to use according to the terms of the permit, issue a "license" to continue the use. These certificates or licenses are in the same class as court decrees as evidence of rights, except that they may be better because of the fact that they are based on proof submitted to a state board or official whose duty it is to protect the interests of the public, and are issued after inspection by those officials, rather than on a court proceeding, where the court is limited to the evidence presented. Rights represented by certificates or licenses can be lost by abandonment or non-use just as any other right, but are not so likely to have been, since the laws providing for them are comparatively recent and the time for abandonment is short. The period of non-use constituting abandonment differs in the different states, ranging from two to seven years where it is defined by law.

Certificates or licenses representing rights acquired in accordance with permits issued by the states and as the results of adjudications made by state boards or officials and based on surveys made and testimony collected by state officials, are, therefore, the best documentary evidence of the possession of rights which are likely to be supplied by the streams in average years; court decrees rank next; while permits from state boards or officials, and copies of filings in county or state offices rank last.

The preceding discussion may create the impression that there are no good titles to the use of water, but that is not the case. The point is that documentary evidence alone is not sufficient to establish either the existence of a water right or its value. Documentary evidence must be backed up by evidence of the existence of a sufficient water supply in excess of the demands of prior rights. This involves the study of records of stream flow and of existing use.

In states having water commissioners these officials keep records of the dates when each ditch receives water and how much it receives. These records covering a series of years will disclose what ditches have good rights and whether there is water in any source beyond the demands of existing rights. Where such records do not exist, it is usually possible to learn from local disinterested parties what ditches receive a good supply, what ditches are ordinarily short of water, and whether there is in ordinary seasons more water than is demanded by existing rights.

Actual use covering a period of years is considered to give a better title than any decree, permit, or certificate, because the basis of all rights is "beneficial use," and the perpetuation of a right depends upon the continuation of use. The prospective purchaser of a water right should look carefully into both the documentary and the physical evidence of the value of the right to be purchased, giving perhaps more attention to the latter than to the former.

RIGHTS TO WATER FROM SECONDARY SOURCES

Except in irrigation districts the water rights offered for sale are represented by agreements which fix the conditions on which water is to be delivered. These agreements usually fix the price to be paid, the terms of payment, and the penalties for failure to make payments when due; describe the land on which the water is to be used; and fix the quantity of water to be furnished. Very generally, the price of water rights is fixed on the acreage basis rather than on the quantity of water to be delivered, although this is not universally true.

Under the United States Reclamation Law, the charge for water rights is on the acreage basis, the whole cost of an enterprise being apportioned on the entire acreage in the project. As soon as the price is determined for any project, a notice is published, giving the size of farm units (the acreage for which one person may obtain water), the price of rights per acre, the quantity of water to be delivered per acre, and the annual charges for water per acre. These items vary for the different projects, and for several the prices have not yet been fixed and water is supplied on temporary rental agreements, under which annual charges only are paid.

The prices vary from $25 to $90 per acre, the average at present (1915) being about $55 per acre. The quantity of water to be delivered also varies, but averages about two and one-half acre-feet per acre. The annual charges, which are supposed to cover the cost of operation and maintenance, are changed from time to time as the expense to be met varies.

Entrymen on public land within a reclamation project take the land subject to the water-right charges, and title is not received until the charges are paid. Failure to meet two successive annual payments forfeits all moneys paid and all interest in the land and water rights.

Owners of private lands under reclamation projects are required to enter into an agreement with a trustee or to subscribe to stock in water users' associations and agree that the associations may sell their lands to secure payments not made when due. The Secretary of the Interior has insisted upon this being done before the lands will be included in a project, which is, of course, before the cost is determined, so that this practice amounts to demanding that owners of private lands give blank mortgages on their lands, with the amount of the lien to be filled in by the mortgagee. The Reclamation Law provides that the owners of the land shall repay the *estimated* cost, and agreements are entered into with certain popularly assumed estimates in mind, although the Secretary of the Interior has insisted that the parties agree to pay the cost, as determined after the contracts have been let. As this cost has very greatly exceeded the unofficial or popular estimates, due partly to increased prices of materials and labor, and partly to enlargements on the original plans, and partly, no doubt, to errors on the part of the engineers, there has been a great deal of discussion over this point, and water users are attempting, in some cases, to limit the amounts of the liens to the popular or informal estimates made at the time the agreements were entered into. It is the evident intent of the law that the land shall repay to the Government the cost of supplying it with water, and this must be done if the reclamation fund is to "revolve" as originally planned. In the spring of 1915 the Secretary of the Interior made an attempt to adjust this whole matter by providing for a revision of the costs which are to be repaid by the water users on the various projects. The plan is for the water users to enter into agreements to accept the revised costs in lieu of those to be paid under existing agreements. For the purpose of making the revision, a local board was appointed for each project, and a general board of three members was appointed to review the reports of the local boards and make final recommendations to the Secretary of the Interior as to the cost to be repaid on each project. There has been some opposition to this plan on the part of water users, on the ground that they are asked in this plan, as in the original plan, to agree to the scheme in advance of the revision, thus obligating themselves to pay an indefinite sum, and making that sum a lien on their lands. The order providing for the revision contemplated that it would be completed within a few months, but it seems likely that it will be a question of years rather than months. Consequently the whole matter of payments to be made by water users on the United States reclamation projects must be considered somewhat unsettled.

While the public notices fix for each project the quantity of water which is to be delivered to each acre of land, the water user, under these projects, as under the others to be described, is, in fact, entitled to his proportionate share of whatever water is available for the enterprise, rather than a fixed quantity in case of shortage.

The terms of contracts under which companies operating under the Carey Act sell water rights are fixed in the contracts between these companies and the states. They specify the quantity of water to be delivered, describe the land on which it is to be used, fix the annual charges, and provide that the water-right contracts shall be exchanged for stock in a new company to which all the works and rights belonging to the construction company will be turned over when a certain percentage of all the rights in the project are sold.

These rights usually are sold on partial payments, and the notes given for deferred payments are made a lien on the land. The contracts usually provide for the delivery of a fixed quantity of water per acre per year, or for the continuous delivery of a stream of a given size for a given acreage, but they provide also for prorating the available supply in case of shortage. This makes it very necessary for the purchasers to look into the rights of the company and the available water supply, for if the supply is limited, prorating will be the rule and not the exception.

In irrigation districts the water right is an incident to ownership of land in a district and goes with the land. Each acre of land in the district is entitled to its share of the water supply available for the district, whatever that supply may be. Here the quantity of water which will be received depends entirely upon the quantity available and the acreage of land in the district, making an examination into the rights of the district itself the only means of forming any idea of the value of the right. Every district has a nominal water supply of a certain quantity per acre in the district, but, as previously stated, this may be only nominal. The supply actually available may be much less.

Water rights in coöperative or mutual companies are represented by stock in the companies, and each share of stock entitles its owner to water in proportion to the number of shares he owns. In these companies water is not delivered in proportion to the acreage, as in the other types just described, but in proportion to the stock owned. Unlike the rights in the other enterprises, these are not attached to particular tracts of land, but the water may be used on any lands reached by the works of the company. The cost of operation and maintenance is raised by assessments on stock, rather than on the land, and the laws of many of the states provide for the sale of stock by the company to recover delinquent assessments. Usually stock may be rented and the lessee may draw the water represented by the stock. In this respect, a right represented by stock in a mutual company differs materially from rights in other companies or in districts. In those enterprises the water may be used only on the land described in the contract, and if it is not needed on that land the owner may not draw it or dispose of it in any way.

Commercial companies have all sorts of schemes for disposing of water, but their contracts have a general similarity. The laws of many of the states prohibit the sale of rights which merely allow the purchaser to get water upon the additional payment of annual charges. In consequence, almost every scheme provides for the purchaser of a water right securing an interest in the works and rights belonging to the company. The scheme is usually the same as that used in Carey Act enterprises, the exchanging of the water-right contract for stock in the company when a certain proportion of all the rights represented in the company are sold. These contracts, like the others, fix the quantity of water to be delivered, the land on which the water is to be used, and the charges which are to be paid annually until the works are turned over to the contract holders. Here again water is to be prorated in times of scarcity. The annual charges will, of course, vary with the cost of operation and maintenance after the works are turned over to the contract holders.

It is seen, therefore, that under practically every type of enterprise, no matter what the nominal quantity of water to be delivered may be, the actual quantity is a share of the available supply, based in most instances on the acreage owned, but in mutual companies on the number of shares of stock owned. All United States reclamation and Carey Act enterprises and most commercial enterprises are to be turned over to water-right purchasers eventually, when the holders of rights will receive stock in companies which will take over the works, but in enterprises of the first two classes the stock will be in proportion to acreage and will be attached to the land described in the contracts, and water will still be divided in proportion to the acreage.

CHAPTER VIII

ORGANIZATION AND OPERATION OF IRRIGATION ENTERPRISES

Nearly one-half of the irrigated land in the United States is supplied with water by small individual and partnership ditches, which are operated without formal organization. These enterprises are becoming constantly less important, however, from the fact that the opportunities for such ditches are largely utilized. There is, however, large opportunity for individual pumping plants, particularly in the Plains regions, where ground water is often found at moderate depths and in sufficient quantities to justify the installation of pumping plants. The individual plant has some advantages, chief among which are independence of rules and regulations and the possibility of obtaining water whenever it is needed, without regard to the needs of others. Under practically every form of enterprise supplying a number of parties with water, it is sometimes necessary to take water in turns, and this means that at such times a farmer must wait for his turn regardless of the needs of his crops.

There are disadvantages in small enterprises which offset the advantages of independence of others, particularly with pumping plants. The farmer with a small irrigated acreage must put in a pump large enough to give him a good working stream of water, and this plant must stand idle a considerable part of the time. The same plant might supply other lands during these idle times, thus decreasing the cost of construction per acre irrigated.

COÖPERATIVE OR JOINT STOCK COMPANIES

The most common type for the organization of companies operating larger enterprises is the joint stock company, usually called a cooperative or mutual company. These companies supply water to about one-third of the land irrigated in the United States, and the works built under the Federal Reclamation and

Carey Acts are to be turned over to such companies when the purchasers of water rights have paid for these rights.

These companies are almost universally of the same type—stock companies with the stock owned by the water users. They are not operated for profit, and there are no dividends on stock. Commonly there is no limitation on the amount of stock which one person may own, but there is a marked tendency for the amount of stock owned to be roughly proportional to the acreage to be irrigated, although there is no rule as to this. Usually stock may be and some is owned independently of the ownership of land. Most of the contracts of Carey Act companies providing for turning works over to the water users provide for the issuing of one share of stock in the new company, organized for the purpose of taking over the works, for each acre to be irrigated. Similarly, the water users' associations, organized to take over projects built by the Reclamation Service, provide for one share of stock for each acre.

Whatever water is controlled by such a company is divided among the stock holders in proportion to the stock held, and this water may be used on any land under the works belonging to the company. A stock holder not wishing to use his share of the water on his own land may rent his stock, and the lessee may use the water delivered on account of this stock. In this way the owner of stock may get a money return, although the company itself pays no dividends. In some companies, however, particularly those taking over Carey Act projects, stock is attached to particular tracts of land, and the water must be used on this land or not used at all.

The costs of operation, maintenance, and improvements are usually raised by assessments on stock rather than by levying charges for the water used, and consequently the ownership of idle stock is not at all profitable. This amounts to a charge for water whether it is used or not, which is the most common system of charging for water at the present time.

There are many minor variations, but most of the companies conform roughly to this general type.

This form of organization had its birth in Utah, where the canals were built largely by the labor of the settlers, who were paid for their labor in stock; that is, they received stock in proportion to the amount of labor supplied. In Utah the Mormon church usually planned and backed these enterprises, and supplied the small amount of cash required. The church received stock for the money put in by it, and later disposed of this stock to new settlers, who were then placed on the same footing as the original builders.

It is evident that in its original form this type of organization is not adapted to the construction of large enterprises. The construction of large canals requires large capital and considerable time—often several years—so that settlers without means, like the Mormon originators of this scheme, cannot maintain themselves until the water becomes available. Speaking generally, the agricultural land of the arid region is uninhabitable until water is provided for its irrigation, and consequently there are no settlers on such land who may combine and build their own irrigation works.

Most of the large canals now controlled by joint stock companies were built by organizations of other kinds and later turned over to these companies. In recent years this change has become a part of most development schemes, Federal as well as private. As just stated, the joint stock company is not suited to construction. Consequently construction is carried on by individuals, construction companies, and by the Federal Government; and land and water are disposed of under agreements providing that when the purchase price is paid their contracts shall be exchanged for stock in companies to which the works are to be turned over. When the works are paid for they become the property of these stock companies and are operated by the water users organized in that form.

In many instances the change has not been a part of the plan of the builders but has been forced upon them, often by financial failure.

In the first great boom in irrigation construction, in the period from 1885 to 1893, the plan of operation was to build irrigation works and sell "water rights" which merely entitled the purchaser to obtain water from the system upon the payment of annual charges. The builders planned in this way to reimburse themselves for the cost of the works and still retain the ownership, and operate them indefinitely for annual charges which would return a profit. This scheme did not work out, however; most of such companies failed, and the works have been bought up by the farmers under them, organized into stock companies. The evident injustice of the original scheme led to legislation against it in several states, and the combination of financial failure and hostile legislation led to the adoption of the plan of selling rights which carry with them a share in the ownership of the works, to be represented by stock in a new company composed of the purchasers of rights.

The joint stock company is usually governed by a board of directors elected annually, and these directors estimate expenditures, make assessments to meet the cost of operation, maintenance, and improvements, and employ the operating force. Assessments are a lien on the stock owned, and stock may be sold at auction to recover delinquent payments. In some of the arid states this sale of stock is provided for by law.

As previously stated, enterprises operating under the Carey Act are turned over to joint stock companies when the works are paid for. This is not provided for by law, either state or Federal, but is provided for by contract between the states and the construction companies. The following paragraphs are taken from a contract between the state of Idaho and the company building one of the largest systems in that state under the Carey Act:

TRANSFER OF POSSESSION AND MANAGEMENT OF CANAL

It being necessary to provide a convenient method of transferring the ownership and control of said canal from the said party of the second part herein to the purchasers of said water rights in said canal and for determining their rights among themselves and between said purchasers and the party of the second part herein, for the purpose of operating and maintaining said canal during the period of construction and afterward and for the purpose of levying and collecting tolls, charges, and assessments for the carrying on and maintenance of said canal and the maintenance and operation thereof, it is hereby provided that as soon as said lands are ordered thrown open for settlement a corporation to be known as the .... shall be formed at the expense of the party of the second part, and the amended articles of incorporation of said company to be in the form which is hereto attached and made a part hereof; that the authorized capital stock of said corporation shall be .... shares, which amount is intended to represent one share for each acre of land which may hereafter be irrigated from said canal. The entire authorized amount of the capital stock of said corporation shall be delivered to the party of the second part herein in consideration of the covenants and agreements herein contained in order to enable it to deliver to purchasers of water rights the shares of stock representing the same. Said shares of stock, however, shall have no voting power and shall not have force and effect until they have been sold or contracted to be sold to purchasers of land under this irrigation system.

At the time of the purchase of any water rights there shall be issued to the purchaser thereof one share of the capital stock of said corporation for each acre of land entered or filed upon. That the party of the second part herein shall, in case said water rights or shares of stock are not fully paid for, require the endorsement and delivery to it of said stock, and shall at the time require of said purchaser an agreement that until thirty-five per cent. (35%) of the purchase price of said stock has been paid the said party of the second part herein shall vote said stock in such manner as it may deem proper at all meetings of the stockholders of said corporation.

But the said second party hereto or the (new) Canal Company cannot in any manner control any of the said system so as to limit the liability of the said second party under the terms of this contract.

The said (new) Company shall have the management, ownership, and control as above set out, of the said canal system as fast as the same is completed and turned over to it for operation by the said party of the second part as hereinafter provided. Whenever it is certified by the chief engineer of the Company and by the state engineer that certain portions of the said canal are complete for the purpose of operation, the same may, with the consent of the State Land Board, be turned over to the (new) Company for operation. Such transfer and operation shall not in any manner lessen the responsibility of the said second party with reference to the terms of the contract, nor shall such consent on the part of the State Land Board be construed as a final acceptance of such portion of such canal, it being always understood that the acceptance of said canal must be in its entirety and that the bond given for the faithful performance of said contract must be made and be liable for the substantial completion of the entire canal system.

Few large Carey Act enterprises have reached the stage of being turned over to the purchasers of water rights, but some have been —notably what is known as the Twin Falls South Side project in southern Idaho.

The Federal Reclamation Act contemplates similar action when the payments for works built under that Act have been made. The provisions of the law on that point are as follows:

> Provided, That when the payments required by this Act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: Provided, That the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress.

It will be noted that in this case the works, although paid for, are not to become the property of water-right purchasers until further legislation providing for passing the title is enacted by Congress. None of the projects has yet approached the stage where it should be turned over to the water users, and consequently no procedure for this change of management has been laid down. Under the law the Secretary of the Interior may fix the time when payments shall begin, and several of the larger projects are running on rental agreements, with no time fixed for beginning payments on the construction cost, thus postponing indefinitely the turning over of the works. The Reclamation Law originally provided for the repayment of the cost of construction in ten annual instalments, and it was assumed that these payments would begin as soon as water was supplied for irrigation, and that the land would be taken up and begin using water as soon as the Service could supply the water. Under such conditions payments would have been made for the "major portion of the lands" within from twelve to fifteen years from the beginning of a project. In practice, however, it has been found that the lands have not all come into use as soon as the water is ready; it has not been possible in all cases to fix the price to be paid as soon as water is ready, necessitating temporary rental agreements; and where the price has been fixed and payments demanded it has been found that the settlers were not able to make the payments. In view of this last fact, on the recommendation of the Secretary of the Interior, Congress has enacted a law providing for extending the time for repayment to twenty years. With payments not yet begun on many projects, and with the time of payment extended to twenty years, the turning over of reclamation projects to companies composed of water users, as originally contemplated, is a matter of the distant future, if it ever occurs. It seems quite likely that before that time arrives Congress will make some other provision regarding the operation of these projects.

The joint stock company seems to be ideal for the control and operation of completed works. It is simple and inexpensive. The water users themselves prescribe the rules which govern their water supply, and they elect the directors who control the works and levy their assessments. These assessments cover only the actual cost of maintenance, operation, and improvements, and no profit or toll is paid to anyone. In most states canal companies supplying water to their own stock holders only are exempt from taxation also.

There are, however, companies which conform to this type of organization but are in effect commercial concerns. In such companies a majority of the stock, and consequently the control of the enterprises, is vested in a single person or a single group with common interests, and the individual or group can and does control the system more absolutely than does a company delivering water under contracts.

COMMERCIAL ENTERPRISES

There are a few enterprises, altogether watering about ten per cent. of the land irrigated, which deliver water for hire to persons who own no interest in these enterprises. As stated in the discussion of joint stock companies, this was a favorite form of organization during the first great boom in irrigation construction in this country. At that time such companies sold water rights under contracts which fixed the conditions and the rates under which the purchasers of rights were to receive water. These were known as perpetual water rights, because so long as the purchasers kept up their payments they were entitled to receive water. These contracts, however, conveyed no right or ownership in the works or rights belonging to the company. Payments for water rights were a sort of bonus to the company, which was exacted before water would be delivered. Before such companies had been long in operation, most of the arid states passed laws prohibiting the demanding of any bonus or other consideration as a condition to supplying water for irrigation. Since the enactment of these laws, commercial enterprises must supply water to any lands within the range of their works upon the tender of the rates prescribed, so long as they have water available. When such an enterprise has not sufficient water to supply all demands, preference must be given to parties who received water during the preceding season.

In most of the states the rates which may be charged by such enterprises may be fixed by some public authority, usually the county commissioners, while the other conditions upon which water is delivered are fixed by contracts between the canal owners and the water users.

Water-right contracts differ in many details but are very much alike throughout the West. They describe the land which is to be irrigated, state the quantity of water which is to be delivered, provide that the water shall not be used on any other land than that described in the contract, relieve the company of any responsibility for a shortage of water, and provide that in case of a shortage, whatever water is available shall be divided pro rata among all contract holders. In other words, the contracts call for the delivery of a certain quantity of water to certain lands, but provide further that, if this quantity of water is not available, the farmer shall take what he can get, and make no claim for damages because of shortage. Rates are most commonly based on the acreage supplied, and most contracts provide for no rebates or allowances on account of shortage.

In recent years a few commercial companies have adopted the quantity rate, and one state, Idaho, has prohibited the sale of water on any other terms. Some companies, notably those on the lower Rio Grande in Texas, have adopted a mixed rate, or rather a quantity rate with a minimum charge which must be paid whether water is used or not. For instance, one company has a rate of three dollars per acre per year and for this price delivers three waterings. Additional waterings may be had for one dollar per acre per watering.

Many commercial companies evade the prohibition against the sale of water rights by buying the land which is to be served and selling the land for a price which in reality is based on the value of the water right rather than on the value of the land. However, this does not seem to violate the law.

IRRIGATION DISTRICTS

Districts are organized and are operated under state laws, and in most states every detail of organization and operation is prescribed by law. Districts are organized on the vote of the owners of the lands within their boundaries (page 105), and the right to receive water from the works of a district goes with the ownership of land—in fact, the right belongs to the land, not to the owner of the land. In most of the states each property owner within a district is entitled to one vote and no more. Montana allows one vote for each forty acres or fraction thereof, and Utah allows one vote for each acre owned within the district.

Districts are controlled by boards of directors, usually having three members, elected annually. Districts are usually subdivided into smaller districts and one director is chosen from each smaller district, rather than all being chosen at large. These directors transact the business of the districts, employ the operating force, and levy assessments. Assessments are usually divided into a levy for operation and maintenance, one for interest on bonds issued, and one for the payment of bonds. The district laws of the states provide that, in case the annual taxes are not levied by the directors of any district, the levy shall be made by the county commissioners. Taxes are collected by the county treasurer, and delinquent taxes are collected in the same manner as delinquent state and county taxes.

All questions of issuing bonds and of incurring any indebtedness above a minimum fixed by law are submitted to the vote of the land owners. It is seen that the land owners have full control of incurring obligations, but, once the obligations are incurred, the county forces the levying and collection of the assessments necessary to meet these obligations.

The district system of organization has the advantage of public control and of being operated in the same manner as schools and other public enterprises. The water rights belong absolutely to the land and go with it, just as does a right to use the public schools or the public highways. It has always seemed to the writer, however, that this is an unnecessarily cumbersome form of organization for the operation of a system which is completed and paid for. The joint stock company is much simpler for that purpose.

Like the joint stock company, the district organization is not adapted to the construction of new enterprises in an arid region and, for the same reason, the land cannot be occupied until the works to supply it with water are built, and consequently the people to form the district are not there. Furthermore, the land in its natural arid state is not worth the cost of the works to supply it with water. Consequently bonds based only on the value of land which is yet to be reclaimed are not very solid. Even if the people are there, a board of directors elected annually from among farmers unaccustomed to business transactions is not the most efficient agency for planning, contracting for, and supervising the construction of irrigation works. If lands are not settled and are not producing crops, they are more than likely to be sold for taxes and are very likely not to bring at sale the amount of taxes levied against them.

In the opinion of the writer the district organization has one field for usefulness and only one, that is for taking over and improving works already built and paying for these works and improvements, and many of the existing districts have been formed for that purpose. In such cases the works are built by centralized organizations of some kind having the necessary continuity of management and policy, and are controlled by parties accustomed to business and to the carrying out of large enterprises. When the lands have been settled and partially reclaimed, they increase in value sufficiently to be good security for bonds sufficient to pay for the works. The issuing of bonds which are a direct lien on the lands, enforceable by taxation, is the simplest and most effective means of raising funds, and the public supervision of the organization of districts and of the levying and collection of taxes tends to give the bonds a standing which bonds based on notes securing deferred payments on the purchase price of water rights, as the Carey Act bonds, do not have. But when the bonds have been sold and have been paid off so that the works are owned absolutely by the lands which are served by them, it seems that some simpler form of organization would do as well. District bonds run twenty years, as a rule; consequently the district organization is quite permanent and it seems likely that an enterprise operating under this form for twenty years will continue in that way.

Recently there has been considerable discussion of the plan of organizing irrigation districts to take over works built by the U. S. Reclamation Service, under proposed legislation permitting the Government to accept district bonds in payment for the works built by it. Under such a scheme the Government would build the works for a project and operate them until the lands were settled, and then turn the works over to a district including the lands of the project in exchange for the bonds of the district in amount equal to the cost of the works. The bonds would run for twenty or more years, but the charges would be levied and collected by the local authorities rather than Federal officials. This would tend to local harmony and would help to obviate the condition of distrust and suspicion which is so noticeable under Federal projects.

It does not seem likely that the Government would sell district bonds taken by it, for that would amount to the underwriting of these bonds by the Government. While the Government could not be expected to actually indorse district bonds, even if it sold them, there would be an implied indorsement which the Government could not escape. In case the bonds should be held until paid off in accordance with the provisions of the state district laws, only interest would be paid for the first ten years, and the principal would be repaid between the tenth and twentieth years. If legislation permitting the Government to accept district bonds is enacted, it is probable that a great effort will be made to have such bonds bear no interest. If this is done, the taking of district bonds issued under present state laws would be more liberal to the water users than the extending of the time of payment to twenty years, in that under the extension law, payments on the principal will begin in five years, while under the district laws they do not begin for ten years.

The proposed change would relieve the Reclamation Service of operating and maintaining works, and place this in the hands of the water users. When the works are paid for—that is, when the bonds are paid off—the projects can either be continued as irrigation districts, or can be reorganized into joint stock companies.

CAREY ACT ENTERPRISES

The transition of Carey Act companies into joint stock companies has already been described. Pending this change, such enterprises are operated by construction companies, and the rights and privileges of water users are regulated by the contracts between states and the construction companies, and between the companies and the individual water users. As shown by the contract quoted on page 197, stock in the new company which is eventually to control the enterprise is issued to the water-right purchaser as soon as he buys, but this stock is immediately turned back to the construction company to be held by it and voted by it until thirty-five per cent. of the purchase price is paid. Most Carey Act contracts call for the payment for rights in ten annual payments. Under such contracts the purchaser would receive and vote his stock in three or four years. The time required for a majority of the stock to get into the hands of the purchasers would depend upon the period required to sell the water rights. If the sale requires several years, the period before the works are controlled by the water users will be correspondingly extended. In the meantime they are operating in just the same manner as commercial enterprises.

UNITED STATES RECLAMATION PROJECTS

As already stated in the discussion of joint stock companies, while the law contemplates the turning over of these projects to companies composed of the water users, none of the projects has even approached the stage when it should be turned over to the water users. In the meantime, these projects are controlled and operated by the Reclamation Service under regulations issued by the Secretary of the Interior. For each project there is a project manager who, with his subordinates, attends to maintenance and repairs, distributes the water, and makes collections. Under the law extending payments to twenty years, and with the amount of these payments and the time of their beginning unsettled, this system of management may be considered practically permanent.

CHAPTER IX

THE PRESENT SITUATION AND FUTURE OF IRRIGATION IN THE UNITED STATES

While the larger part of the land irrigated in the United States is served by works built or controlled by individuals, partnerships, or coöperative organizations, present development is largely in the hands of the United States Reclamation Service, Carey Act companies, irrigation districts, and commercial companies carrying out large enterprises and disposing of land and water to settlers. In sections where underground water can be obtained by artesian flow or by pumping, considerable areas are being reclaimed by individuals, but the aggregate area is small compared to that in the large enterprises.

The report of the United States Reclamation Service for the year ended June 30, 1914, showed that the Service had under its control twenty-eight projects, including 2,973,048 acres, only six of which, or about 460,000 acres, were reported completed. The uncompleted projects, therefore, included about 2,500,000 acres. The acreage which was reported irrigated in 1914 was 761,271 acres, while water was available for an acreage of 1,343,193 acres, showing water available for 581,922 acres not yet irrigated. This leaves an area of 2,211,777 acres under projects on which construction is now in progress which is not yet irrigated, and 1,629,855 acres for which water is not yet available. The area irrigated in United States reclamation projects increased in 1914 over 1913 by 62,088 acres, in the preceding year by 76,716 acres, in the year preceding that by 91,258 acres, and in the year preceding that by 62,795 acres. It is seen that the average increase has been 73,214 acres per year. On the assumption that this rate continues for the future, the projects now under way provide for the expansion in the irrigated area for more than thirty years; and the acreage for which water is already available but not used will take care of the expansion for more than seven years. The report of the census of 1910 showed substantially the same situation for the arid region as a whole in the census year, and the situation has not changed materially since that time. The acreage which existing enterprises were supplying with water in 1909 were capable of supplying in 1910, and the acreage included in these enterprises was reported as shown in the following table:

Type of Enterprise	Acreage Irrigated in 1909	Acreage Enterprises Were Capable of Irrigating in 1910	Acreage Included in Projects
U. S. Reclamation Service..	395,646	786,190	1,973,016
U. S. Indian Service........	172,912	376,576	879,068
Carey Act Enterprise.......	288,553	1,089,677	2,573,874
Irrigation Districts.........	528,642	800,451	1,581,465
Coöperative Enterprises....	4,643,539	6,191,577	8,830,197
Individual and Partnership Enterprises..............	6,257,387	7,666,110	10,153,545
Commercial Enterprises....	1,451,806	2,424,116	5,119,977
Total................	13,738,485	19,334,697	31,111,142

In the report of the census, the writer summed up this matter as follows:

> One of the most significant facts brought out by the special census of irrigation was the existence of very large areas not yet irrigated for which works were already built or were under construction.

As already stated, the acreage which enterprises were reported as capable of irrigating in 1910 was more than 5,500,000 acres in excess of the acreage irrigated in 1909, while the entire increase in acreage irrigated from 1899 to 1909 was only a little more than 6,000,000 acres. In other words, the average annual increase in irrigated acreage for the ten years preceding 1909 could be continued for almost another decade without the construction of additional works. Furthermore, the fact that the acreage included in all enterprises, either completed or under construction in 1910, was more than 17,000,000 acres in excess of the acreage irrigated in 1909, would indicate that a yearly increase equal to the average annual increase for the decade 1899-1909 could be made in the amount of irrigated acreage for almost thirty years without the undertaking of new enterprises. Although many of these enterprises will undoubtedly prove incapable of supplying the entire acreage which is included in their plans, and the figures cannot be taken as an exact measure of the areas for which a water supply is being made available, there is probably sufficient ground for stating that the yearly increase in the irrigated acreage shown for the period 1899-1909 could continue for at least another decade through the completion of the enterprises under way in 1910 and without new undertakings. In the United States it usually takes at least twenty years to bring a large irrigation enterprise into complete utilization, and in any time of normal progress there will always be a large area not yet irrigated under enterprises which are not fully developed. A large but not definitely known part of the unirrigated land is in farms which have been taken up and settled on, but which are only partially cultivated or irrigated, and hence only part of the unirrigated land is open to settlement in the sense of being outside of farms. As many such farms, however, will undoubtedly be subdivided, part of the land included in them should be considered as available for settlement. The census figures seem to indicate that the construction of irrigation works has exceeded to some extent the effective demand for irrigated land, and that there should be and will be a check in the initiating of new enterprises while those already undertaken are being more fully utilized.

As suggested previously, the situation has not changed materially since 1910, and while the figures given are not exactly correct for the present time, they do indicate correctly the condition which exists today—large areas of land under projects either completed or under construction not yet under cultivation and irrigation, with no effective demand for this land.

The condition just described has led to the financial failure of many enterprises, which have not been able to meet their bonded and other obligations, and this in turn has given such securities a bad name, so that at present it is almost impossible to finance new irrigation enterprises of any character. As is shown by the reports referred to above, the condition on the U. S. reclamation projects is exactly the same as that on private projects, except that the Reclamation Service is not obligated to repay either the capital put into its works or interest on this capital. The last annual report of the Service (1914) shows a gross building charge to June 30, 1914, of $91,664,628.73, and a total cost of operation and maintenance to the same date of $5,005,168.08, making a total cost of $96,669,796.81. The total receipts up to June 30, 1914, were, for building charges, $3,058,459.41, for operation and maintenance $1,895,827.88, and for water rentals $2,248,615.57, or a total of $7,202,902.86. In other words, the total receipts from building charges, operation and water rentals and maintenance, since the beginning of operations under the Reclamation Law—12 years—are less than enough to pay eight per cent. interest for a single year on the amount expended on these works. In the report referred to, the director calls attention to the fact that the total accruals of construction charges, for the fiscal year 1914, were less than two per cent. of the net investment to June 30, 1914. It is evident that, had these works been built on borrowed capital on which interest had to be paid, these enterprises would have defaulted just as private enterprises have done.

There has been a great deal of discussion of methods of securing capital for the construction of new irrigation enterprises, and the usual inference is that capitalists are in the wrong in not coming forward and putting their capital into such enterprises, but, as it stands today, few, if any, of such enterprises, public or private, are paying any return on the capital invested. The great need of the West now is the utilization of the works already built, not more works. This does not mean that there are not localities where peculiarly favorable conditions exist, in which irrigation enterprises have a good prospect of success. There are undoubtedly such places, but they are exceptional.

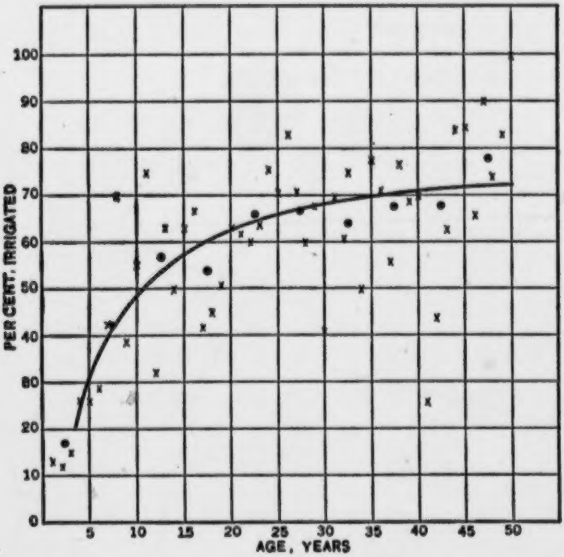
The writer recently visited a project which is typical of many scattered throughout the arid region, and typical also of the whole situation. The enterprise was begun some seven or eight years ago and the works have been completed for three or four years. The enterprise included some 80,000 acres, and works were built to supply that acreage. After seven or eight years water is supplied to about 12,000 acres. In other words, the works are utilized to about one-seventh of their capacity. Development under this project is nearly at a standstill. The land actually in crop cannot pay the cost apportioned against the other 68,000 acres, and it is a question of running at a loss for years or closing down altogether and losing the capital invested.

The following quotation from the *Reclamation Record* of October 14, 1914, describing conditions on one of the large Government projects, indicates that the enterprise just referred to is typical.

The ——— Project needs many more farmers. Only one-third of the land for which water is available is in cultivation. While the present settlers probably are making as rapid progress in preparing their raw lands as their means will permit, the fact remains that the Service is operating an irrigation system on the basis of only one-third its capacity. Obviously this is not economical.

The preceding statements relate, of course, to enterprises now developing. The census of 1910 showed an acreage of about 13,500,000 acres irrigated, and the larger part of this represents the most successful and most highly developed agriculture in the United States. The financial distress of the enterprises now in process of development is no indication that irrigation is not a success as an agricultural process. It indicates merely that irrigation construction has been overdone, and that we have not yet hit upon a successful plan of promoting and developing irrigation enterprises.

The immediate cause of failure, except in cases of serious mistakes as to cost or the sufficiency of the water supply, has been the slowness of settlement, and this seems to be unavoidable. The lands are uninhabitable until a water supply is provided, and this necessitates large investments in advance of settlement. When a large project is completed, it is not possible to secure at once settlers to come right in and take up the land. Nor is it possible for the settlers who do come to put all their land immediately into cultivation. As a result,



the promoters of irrigation enterprises must not merely provide capital to build irrigation works, but must wait years for the return of their investments. The diagram on page 225, based on the returns of the thirteenth census, shows the average rate of settlement of irrigation enterprises in the United States.

The census schedules show, for each enterprise, the acreage included in the project, the acreage irrigated in 1909, and the date when the project was initiated. The age of each project used in preparing the diagram is the number of years between its initiation and 1909, and the percentage irrigated is based on the acreage in the project and the acreage irrigated in 1909. The vertical scale represents percentage and the horizontal scale represents age. All projects including 5,000 acres or more for which all of the facts needed are reported have been included in the averages, the number being 522. The percentage shown for each age, indicated by a small cross, is the average for all the projects of that age, while the heavy round dots represent the averages for all projects coming within the five-year groups. The curve is based on the round dots. Beyond the forty-year line so few projects are represented that the curve cannot be considered very reliable. In the forty-first year, for instance, only one project is represented, and that one shows only twenty-six per cent. of its land irrigated; in the fiftieth year, also, only one project is represented, and that one reports the entire acreage irrigated. For the five-year periods under forty years the number of projects is sufficiently large to make the average thoroughly reliable, and it is believed that the curve represents very accurately the average rate at which the lands in irrigation enterprises are brought into use. As shown by the curve, at the end of ten years from its initiation, the average irrigation project is watering about fifty per cent. of its land; at the end of twenty years it is watering a little more than sixty per cent.; at the end of thirty years it is watering less than seventy per cent., and at no time will it water more than seventy or eighty per cent. of its land. There are, of course, exceptions to this rule. Of the

522 projects included in the averages sixty, or a little less than twelve per cent., reported their entire acreages irrigated. It is not likely that all of these statements are true, and it seems probable that not more than ten per cent. of the irrigation projects including over 5,000 acres, ever supply water to all of the land included in them. In the past the facts brought out by this diagram have not been given sufficient consideration by promoters. Estimates of returns have been based on rapid settlement of the entire acreages, while in fact settlement is slow, and returns can be expected from only about seventy-five per cent. of the land. It is believed that this curve will be a safe guide to the promoters of irrigation enterprises, and that those who count on a more rapid or more complete utilization of the lands in their projects will be on unsafe ground.

Two possible remedies suggest themselves: (1) The building of works by parties who get control of the land as well as of the water, and themselves put the land under cultivation and farm it until it is sold to settlers; and (2) the permanent operation of enterprises by the agencies promoting them, under a system of charges which will enable the owners to reimburse themselves in later years for the deficits arising in the earlier years.

The first plan would require large capital, and also changes in our present land laws to permit of the acquisition of large holdings of land. Under such a system the company undertaking the reclamation and sale of a tract of land would build the necessary works, prepare the land for irrigation and put it into cultivation, either by hiring labor or under a rental scheme, or under a combination of the two. This would provide for bringing the land into production at once, so that the whole investment would be productive.

Probably the greatest drawback to rapid settlement and to rapid reclamation of the land taken up is the lack of capital in the hands of possible and actual settlers. The scheme proposed would overcome this obstacle by having the development company equip and stock the farms as well as operate them. These farms might be leased under options for purchase in all degrees of completeness of equipment. The settlers with sufficient capital could buy outright; those with less capital could lease under contracts providing that they were to furnish all or any part of the equipment; those with almost no capital could lease under contracts providing that the company would furnish all equipment and stock; while those who have nothing could be employed as laborers, possibly taking part of their pay in land or in some sort of stock representing an interest in land.

Such a scheme is approached in the rice-growing districts of the Gulf states, where all grades of leases from the owners—from those furnishing merely land to those furnishing everything but the labor—are in use. The difficulties of the scheme increase with the size of the enterprises, but the construction companies, with their knowledge of finances and their acquaintance with the sources of money, are in much better position to secure the capital necessary for developing land and bringing it into cultivation promptly than are the farmers who settle the lands.

This scheme will require safeguarding to prevent the acquisition and holding of large areas of land by irrigation companies permanently, but this can be controlled by legislation.

The adoption of this scheme by the Reclamation Service, for instance, would necessitate the Government becoming a farmer on a large scale, which would be quite a departure from present practice, but there does not seem to be any good reason why the Government could not develop land in this way if it seems wise to do so. It will mean a much larger investment by the constructing agency, but it will mean a much more prompt and certain return on the investment. It will mean the opening of the opportunity of the West to the people who are now barred by lack of capital. On the other hand, it will mean a check on excessive construction because of the larger capital required and the consequent added necessity for prompt return on the money advanced. Works for which there is no real demand will not be built, and cost which is greater than agricultural returns will justify will not be so apt to be incurred.

The second plan suggested is the permanent control of the works by the construction company or the Government, and the supplying of water for hire. This would be applying to irrigation the common plan of supplying water to cities through the agency of public-service corporations. There has always been in this country a very strong belief that the separate ownership of land and the water to irrigate that land was dangerous. In fact, the common theory is that ditches not owned by the water users are merely carriers and that their owners have no right to the water carried, while the rights to water belong to and attach to the land irrigated. The permanent ownership and control of irrigation works by the Government or a corporation would not conflict with these theories. The constructing agencies could be made common carriers in fact as well as in theory, with their water rates subject to public control, as they are now in several states, leaving rights attached to the lands.

Under such a plan there would be no attempt to make the settlers repay the cost of construction directly within a fixed period, but the cost of the works and any deficit in operation and maintenance expenses arising during the earlier years could be taken into consideration in fixing rates in the later years, so that the revenues would eventually pay interest and repay the capital. In fact, this scheme may prove to be the solution of the present troubles of the Reclamation Service. It has been demonstrated that settlers cannot reclaim the land and repay construction costs in ten years. It may develop that they cannot do it in twenty years. But they may be able to pay rates which in the future will equal interest plus the cost of operation and maintenance, with a small amount toward a sinking fund. With public record of all expenditures and public control of rates, based on those expenditures, it does not seem that the farmers are in any greater danger of extortion or of unfair treatment than if they actually owned the works.

The most notable feature of irrigation development in the United States in the last few years is the enormous increase in the cost of irrigation works per acre to be irrigated. The average cost per acre to be served, as shown by the successive censuses, taken in 1890, 1900, and 1910 were as follows:

1890	$8.15
1900	8.91
1910	15.92

Each of these averages includes the cost of all works previously built, so that the cost of works built between 1900 and 1910 was sufficiently above the figure given—$15.92—to bring the average for all the land that was reclaimed up to that time up to this figure. On the basis of the increased total acreage irrigated and the total increased cost between 1900 and 1910, the average cost per acre for the works built during that time was about $40 per acre, or more than four times the average cost per acre for works built prior to that time. The year 1910, however, was in the midst of a period of great activity in the construction of irrigation works, and large amounts had been expended on works not completed at that time, making the figure last given—$40 per acre—higher than the actual cost for the acreage then irrigated. It seems likely that the correct average for the works built between 1900 and 1910 was about $30 per acre. This is something more than three times the average cost per acre reported by the census of 1900.

That this is not an extravagant statement is indicated by the fact that the latest figure reported by the U. S. Reclamation Service for the average cost per acre for works built by that Service is $55 per acre, and many Carey Act enterprises are asking more than that for water rights.

Upon the urgent request of the Secretary of the Interior, and with the earnest support of the Representatives of the Western states, the last Congress passed an act extending the time for repayment of the cost of U. S. reclamation projects to twenty years, on the ground that it was impossible for the settlers on these projects to make these payments in ten years. Private irrigation enterprises seem to be in the same situation. This raises the question whether the cost has not gone beyond "what the traffic can bear."

There is no way to determine this directly as data as to other features of the cost of growing crops in the arid and humid regions are not available. It is certain that the agricultural success of irrigation with works costing less than nine dollars per acre, on the average, gives no assurance of success with works costing three to six times that much. Furthermore, the larger enterprises carried out prior to 1900 were generally financial failures, and the present users of the works built got possession of them for much less than even the low cost then prevailing.

Speaking generally, the old days of monopoly prices in local markets are gone. The products of the newer irrigation projects cannot be consumed locally but must enter the general markets of the country and the world. The arid lands must compete with the world in supplying fruits, breadstuffs, and meats for the general markets. It then becomes a question of the relative cost of producing and marketing crops from the arid lands and from lands in the East and Central West which do not require irrigation but do require drainage, clearing, or fertilizing. It might easily be true that land irrigated at a cost of nine dollars per acre could compete with Eastern lands when lands irrigated at a cost of twenty dollars to sixty dollars per acre could not.

In this competition the West has the advantage of a stable climate, which insures the development and harvesting of crops, on the assumption of a sufficient water supply, and a fertile soil not leached and washed by heavy rainfall. It has the disadvantages of a high cost of water and long distances from markets, involving heavy freight charges.

Not only must the West compete with the East in marketing its crops, but it must compete with the East for the settler himself. Agricultural development, like water, tends to seek its level, and go where crops can be grown and marketed to best advantage, and every increase in the cost of irrigation will tend to force development onto other land and leave the irrigated land above the level to which settlement and development will rise. Whether this has happened already can be determined only by the result. It is certain that at present not nearly all the land for which water is available is used, and many of the farmers who are cultivating irrigated land have not been able to meet the payments on their land as they became due. Easy terms of payment, in the form of an extension of time for repayment of cost, will, of course, help the irrigated land in the competition. Similarly, if the irrigation enterprises fail financially and the works are bought in by the settlers at less than they cost, that will help, since the cost to the farmer is what counts in enabling him to compete with others.

Under the recent law extending the time of repayment on Reclamation projects to twenty years, those payments equal an average annual payment of five per cent. of the cost. As one member of Congress stated it, this amounts to charging the farmer five per cent. interest on the cost of the works and at the end of twenty years presenting him with the principal. It would seem that this extremely liberal arrangement should enable the farmer on Government irrigation projects to compete with the Eastern farmer if irrigated lands can ever compete with non-irrigated.

The settler on private projects, however, gets no such advantage. He must pay not only the cost but interest, usually at more than the five per cent. payable on the Government projects. It would seem, then, that if the settlers on the Government projects cannot make a success, there is little hope for success for the settlers on any other projects—provided the companies originally promoting these projects survive and attempt to enforce the payments due from settlers. If these private enterprises fail, and the farmers get control of the works at a price representing only a small part of the original cost, the settlers under private projects will not be at a great disadvantage as compared with those under Government projects.

In the nature of things, future development will be at a constantly increasing cost, and if the present cost is too high to be repaid, only much higher prices can justify further expansion by parties who expect to make a profit on their investments. This would seem to limit future development to public agencies of one kind or another.

Past experience and the present situation seem to indicate that irrigated lands cannot be expected to repay directly the cost of irrigation works, with interest, as is ordinarily expected of investments generally. Past experience demonstrates, however, that if the loss to original investors is overlooked, irrigation has been a decided success. This raises the question whether the development of its arid lands is not of sufficient value to the Western states and to the country as a whole to justify subsidizing it to a certain extent. In other words, cannot the states afford to pay by general taxation all or a part of the cost of construction of irrigation works for the sake of the development of their resources and the creation of taxable values? And cannot the Federal Government afford to pay a part of the cost of such works for the sake of developing the country and the indirect benefit of the country as a whole?

Under present schemes the farmer is expected to pay the cost of works in from five to twenty years, but the works for which he pays and the values which he creates are expected to last indefinitely. The state continues to collect taxes on the land at the values created by irrigation for all time. Why not have the state pay a share of the cost and reimburse itself, not by taxes levied on that particular land for that specific purpose and for a limited time, but by its general taxes extending over an indefinite period? The lands developed in this way will contribute through taxation to the general expenses of the state as well as to their own reclamation. It amounts to the state making an investment on which it will get returns for all time. Exactly the same argument would apply to the county.

For the Federal Government the case is not quite so clear, since direct taxes are not levied by it. It does, however, reap an indirect benefit from the development of any part of the country and can well afford to contribute to this development, as it is doing under the present law. The principle of subsidizing Western development is well established in the aiding of the Pacific railroads; in the Reclamation Law, which, as already pointed out, amounts to donating the cost of the works to the water users at the end of twenty years of interest payments; and in the Carey Act, which was intended to help irrigation development by donating the land to the states.

Such a system of local, state, and Federal aid to irrigation has been adopted in Italy. Under the Italian scheme the Federal Government pays annually for ten years three per cent. of the cost of the works, two per cent. annually for a second period of ten years, and one per cent. annually for a third period of ten years, thus contributing 60 per cent. of the cost of the works in a period of thirty years. The provinces and communes in which the works are located each contribute one-tenth as much as does the Federal Government, and the interested parties pay the balance. In addition to this, the increased value of the land due to irrigation is not taxed for a period of thirty years. This is cited merely as an illustration of the scheme suggested, not as an indication of the proportions in which the various agencies should contribute.

A possible scheme, suggested by the Italian law, would be to provide for the creation of irrigation districts including lands to be reclaimed, the preparation of plans for works and a scheme of disposal of lands, which must be approved by the county, the state, and the Federal Government. Each of these agencies in approving the plan will bind itself for its share of the cost. If the land is not yet settled the promoters should enter into contracts specifying just what they are to do, and how and on what terms the lands are to be disposed of and settled. With the county, state, and Federal approval of plans, and the supervision of construction by one of these agencies, or by a board representing all of them, and contributions to the cost from all of these public agencies, there should be no difficulty in borrowing the capital necessary for the construction of the works. Without going into details, the following general features are suggested:

1. Provision for the segregation for reclamation of tracts of public land as is now done under the Carey Act.

2. Provision for the reclamation of similar tracts of state or private lands, or of tracts partly public and partly private.

3. Provision for the creation of districts composed of such lands, in general like the present irrigation districts.

4. Provision for the submission of proposals for the creation of such districts and the construction of works to supply the lands with water in somewhat the same manner as Carey Act proposals are now submitted.

5. Provision for the approval of such pro-

posals by all the contributing agencies, and for the pledging of these agencies to contribute the amounts agreed upon.

6. Provision for the issue of bonds which shall be made a lien on the lands of the districts, to be enforced by taxation, as is now done in irrigation districts.

7. Provision for the disposal of lands to settlers, subject to the bonds issued to secure funds for construction.

8. Provision for the enforcement of the lien on the land in case there is default in the payment of interest or principal.

There is little doubt that the arid lands of the West will be developed to the full extent of the water supply. The only questions are: How will this be brought about and how soon will it take place? It is evident that a successful plan for orderly development without large losses to capitalists and equally large but more widely distributed losses to unsuccessful settlers has not yet been worked out. It is the belief of the author that development will be along the following lines:

1. A gradual expansion of the acreage irrigated throughout the arid region, but more especially in the Great Plains, by individual or small community pumping projects.

2. A gradual enlargement of the acreage irrigated under existing projects by a more economical use of water based on a better understanding of correct irrigation practice. Such expansion can be made at smaller cost than any other because it does not involve the construction of new works.

3. The development of comparatively small projects by private agencies where conditions are peculiarly favorable, under some plan for more or less complete utilization of the land and water by the constructing agency pending the sale of land to settlers.

4. The development of larger projects by some kind of coöperation between public and private agencies involving a high degree of public supervision and some public contribution to the cost of the work which is not to be repaid except in the form of general taxation.

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